S. HRG. 115–37

INNOVATION IN ACTION—MICROGRIDS AND HYBRID ENERGY SYSTEMS

FIELD HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

JUNE 10, 2017

Printed for the use of the
Committee on Energy and Natural Resources

Available via the World Wide Web: http://www.govinfo.gov

U.S. GOVERNMENT PUBLISHING OFFICE
25–978 WASHINGTON : 2018

COMMITTEE ON ENERGY AND NATURAL RESOURCES

LISA MURKOWSKI, Alaska, *Chairman*

JOHN BARRASSO, Wyoming	MARIA CANTWELL, Washington
JAMES E. RISCH, Idaho	RON WYDEN, Oregon
MIKE LEE, Utah	BERNARD SANDERS, Vermont
JEFF FLAKE, Arizona	DEBBIE STABENOW, Michigan
STEVE DAINES, Montana	AL FRANKEN, Minnesota
CORY GARDNER, Colorado	JOE MANCHIN III, West Virginia
LAMAR ALEXANDER, Tennessee	MARTIN HEINRICH, New Mexico
JOHN HOEVEN, North Dakota	MAZIE K. HIRONO, Hawaii
BILL CASSIDY, Louisiana	ANGUS S. KING, JR., Maine
ROB PORTMAN, Ohio	TAMMY DUCKWORTH, Illinois
LUTHER STRANGE, Alabama	CATHERINE CORTEZ MASTO, Nevada

COLIN HAYES, *Staff Director*
PATRICK J. MCCORMICK III, *Chief Counsel*
BRIANNE MILLER, *Senior Professional Staff Member & Energy Policy Advisor*
BENJAMIN REINKE, *Professional Staff Member*
ANGELA BECKER-DIPPMANN, *Democratic Staff Director*
SAM E. FOWLER, *Democratic Chief Counsel*
BRIE VAN CLEVE, *Democratic Professional Staff Member*

CONTENTS

OPENING STATEMENTS

WITNESSES

ALPHABETICAL LISTING AND APPENDIX MATERIAL SUBMITTED

INNOVATION IN ACTION—MICROGRIDS AND HYBRID ENERGY SYSTEMS

SATURDAY, JUNE 10, 2017

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Cordova, Alaska.

The Committee met, pursuant to notice, at 10:03 a.m. AKST at the Cordova Center, Cordova, Alaska, Hon. Lisa Murkowski, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

The CHAIRMAN. Well, good morning. It is a clear sign of success when you have to open the back of the hearing room and add additional chairs. So thank you all for being here.

This hearing of the Energy and Natural Resources Committee for the United States Senate will come to order. I would like to welcome all those who have joined us this beautiful Cordova morning.

I would like to start by thanking the community of Cordova for hosting us today. Mayor, it is always good to be back in your town. I know that I am not supposed to pick favorites among communities.

[Laughter.]

But I think the folks here in Cordova know that I have a very, very special place in my heart for this community and for its people and for its fish.

Tonight is always a fun evening where we recognize the value, the benefit and really, all the good that comes to a community when you have good, strong resources such as our Copper River salmon. So there is good reason to celebrate, and that reason to celebrate actually allowed us to select Cordova as the site for a field hearing for the Energy Committee.

When Mayor Koplin appeared before the Committee in Washington, DC, earlier this year, we were speaking about infrastructure and the discussion was pretty broad-ranging. We had the Mayor of Cordova speaking about a community like Cordova—that is islanded in the sense of not being part of any infrastructured grid. His testimony was so compelling in how he described the attributes of this beautiful fishing community that it sparked others on the Committee to say, maybe we should have a field hearing there. I think it might have been suggested initially by Senator Franken, and Senator Cantwell and I looked at one another and said, why not?

[Laughter.]

Why not?

The opportunity to be here in person to see the integrated energy system that has helped move this community off of diesel generation is why we are here this morning, not just to focus though on Cordova, but what it is that has been done in Alaska, working with the benefits of our national labs and working with those here in the state to really be pioneering and innovating in the area of energy.

I am pleased to be able to bring to Cordova my friend and my Ranking Member on the Committee, Senator Cantwell. This is her second visit to the state now in the past 18 months.

We had an opportunity to go to Bethel not too many months ago with Secretary Moniz and several other colleagues looking at a different aspect of energy, but the focus on technology innovation is something that we share great interest in.

We started off this energy trip by stopping in Seattle yesterday, and Senator Cantwell hosted as we toured the Bullitt Center, the world's greenest commercial building. When you think about innovation in building technologies and how so much can be done in a manner that you barely even notice it, looking at what the Bullitt Center has done is incredibly inspirational.

We also had an opportunity to visit McKinstry where we talked about workforce training, cybersecurity efforts and just the collaborative efforts that go on with cybersecurity, efficiency through integrated systems, as we look at smart buildings and how we can better monitor them.

Then we capped off the morning with a discussion with Bill Gates about the future of energy innovation.

It was a pretty inspirational morning, and I really thank Senator Cantwell for putting that together. But it is a great opportunity, I think then, to take those discussions and what we learned yesterday about that energy for the future and then bring it back home, on the ground.

What does it mean? Particularly to high-cost energy states, like Alaska, but where we have extraordinary opportunity with our renewables, where we have incredible innovation that is going on in small ways, in very discreet ways that perhaps do not make the front page of anybody's newspaper except, perhaps, the Cordova Times. But also how we can help, really help build that out, because I think we recognize that innovation is almost a necessity here in Alaska.

Self-reliance, ingenuity—these are hallmarks of the people. We think about how our communities are so isolated. Our energy infrastructure in this state is effectively the interconnected grid that runs from the Kenai Peninsula up to Fairbanks. But so many of our communities are isolated by our geography, our distance, and have to rely on local generation to supply power.

In so many of these communities, you have situations where you have the fuel barge that comes in once, twice a year. Mayor, in your community, and many in the AVEC region, that is your reality. How you deal with that in cold, remote environments is very, very difficult. Recognizing that so many of our isolated communities have partnered with the state and the Federal Government to integrate renewable resources into their microgrids in an effort

to provide greater sustainability and, of course, greater affordability is so important.

We are going to hear from a great panel this morning. Mayor Koplin will talk to us about what it is that we have seen here in Cordova and how that level of innovation has made a difference beyond just this community.

We also welcome this morning Gwen Holdmann, who is the Director of the Alaska Center for Energy and Power (ACEP). Some of the innovative ideas that we have seen coming out of ACEP are really, again, very inspirational.

Meera Kohler, who is well known here in Cordova and around the state, is the Chief Executive Officer of AVEC, the Alaska Village Electric Cooperative.

It is not too often that you have a Senate Energy Committee hearing where you have witnesses who have a six pack of beer in front of them.

[Laughter.]

Geoff Larson, who is the CEO and Co-Founder of the Alaskan Brewing Company, will provide, I think, a very important lesson to us in terms of the types of innovation that we can see that really do help our small businesses become more than small businesses. The leadership that they have embraced down in Juneau is really quite remarkable.

Dr. Abraham Ellis, our out-of-town or out-of-state visitor today, we welcome you. Dr. Ellis is Principal Technical Staff for the Sandia National Laboratories and his focus is on renewable integration in remote areas.

So again, we think about the innovation and how innovation is best facilitated when you have collaboration at different levels, whether it is the local, the state, the tribal, the federal. This is how we can be helpful at the federal level to try to help build out those frameworks.

We have a couple things going on in Washington that perhaps you have not heard about because the Washington news has been preoccupied by other things. On Thursday morning, there was a very important hearing in Washington and it was not the Senate Intelligence Committee, it was our Energy Committee, that was not talking about the former Director of the FBI, but we were talking about innovation in energy and how it drives down costs. It was, I thought, a great, exciting, dynamic hearing. I think more people should have plugged into that one for, really, direction and inspiration in terms of what can be had to help advance this country.

Senator Cantwell and I continue to work on our energy bill that we have been working on now for about a year and a half, maybe two years. We have a partnership in energy that, I think, is recognized in Washington as being good, constructive, enduring and persistent and we will persist with our efforts to get energy updates that will help our communities, our country, for the long haul.

So, Dr. Ellis, I appreciate you and all the members of our panel being here. I want to recognize those here at the Cordova Center that have helped to facilitate this hearing this morning—Cathy Sherman, Mimi Briggs and Jason Gabrielson, as well as the Energy Committee staff that have helped to facilitate it.

Senator Cantwell, I cannot thank you enough for being here. I appreciate not only your engagement on this issue here this morning but the bigger aspects of energy policy that together we are working to help advance.

So, welcome. The floor is yours before we turn it over to our panel of distinguished witnesses.

STATEMENT OF HON. MARIA CANTWELL,
U.S. SENATOR FROM WASHINGTON

Senator CANTWELL. Well, Madam Chair, thank you so much for this invitation to come to Cordova. I have to be honest, when we had our hearing in Washington, DC, and the Mayor promised Copper River salmon, he had my attention.

[Laughter.]

My ears perked up. I noticed last night when we got in, we almost had to speak in code to get it on the menu.

[Laughter.]

I thought when we told the waitress and she, kind of, looked over toward the Mayor, she was like, oh yes, it is on the menu, okay.

[Laughter.]

So, thank you, Mayor.

[Laughter.]

For delivering it, and for the hospitality. Cordova is well known in the Puget Sound region and we appreciate the relationship between our fishing industry and so many aspects of the economy.

I am sure Mr. Larson is going to tell me about how he buys hops from the Yakima Valley and many, many other things.

[Laughter.]

Our states are tied together and they have been historically, and we continue to work together on that. I look very much forward to listening to the panelists and hearing about these issues this morning.

I want to thank you, Madam Chairman, for coming to Seattle yesterday, to tour the facilities at McKinstry and the Bullitt Center. I think we agree that the next steps in energy system delivery improvements need to be made so that we can continue to drive down costs to our consumers and make our businesses competitive.

I would have to say one of the highlights of my day yesterday was watching Senator Murkowski show a picture to Bill Gates of how to grow lettuce in a small container in her office, as is done by so many villagers all across Alaska in the school system. I just thought that was so great because we had just heard this global picture about energy and I think she was doing a fantastic job of bringing it right back down to today, because what we are able to deliver today really matters to the people of Alaska.

I thought you would have been proud of her and proud of her focus on these issues, just as you should be, as it relates to the Energy Policy Modernization Act that we have been working on. As she mentioned, we were successful at getting it out of the Senate but did not quite get the full attention of our House colleagues. We are now trying to get their full attention as they have a little more time. But let me assure you there is no deterrent here when it comes to Senator Murkowski's dedication to this issue. She and I, with her taking the lead, marched across the Capitol one night at

ten o'clock to get something out to staff and house members, trying to get their attention. So, she will go the extra mile, and I thank her for that.

I thank all of our witnesses today for their contribution to this discussion.

You know, today's topic about microgrids and hybrid energy systems is really, really important, and the one thing I hope that Alaskans take away from this hearing is how important it is that you continue to pioneer in this area.

There are so many important things to discuss, but clearly the concept of "necessity is the mother of invention" comes to mind here, that Alaskans are dealing with this issue of anywhere from $.50 per kilowatt to $1.50 kilowatt hour in rural villages. So 5–15 times the average of what a consumer is paying in the lower 48 really does drive the level of discussion and attention to detail here on this issue.

By making sure that Alaskans continue to look at ways to diversify all of the very vulnerable fluctuations in oil prices is something, I think, we are going to hear about, as well as reliable hybrid energy systems with renewable microgrids, coupled with diesel and renewable sources.

I can't wait to hear how all of these things—hydro, wind, geothermal—are working together to help Alaskans maximize and create opportunities.

I know that Alaskans are global leaders, not only in self-reliance, but also in microgrid technology. This is something that would have huge applications all around the globe, and you are continuing to pioneer here. Alaska is already home to 200 microgrids, 70 of which are powered by renewable sources, including hydropower, biomass, geothermal, wind and solar. That is 12 percent of the world's renewable hybrid microgrid systems, right here in Alaska.

You really are pioneering something that will pay dividends for all of us in the future—smarter, cheaper controls, integration of technologies, microgrid solutions—not just for remote communities, but for hospitals, for schools, for our challenges as we look at reliability.

And the Chair mentioned this issue a little bit, of cybersecurity. We definitely had a discussion yesterday about that, about what we need to do to upgrade the entire grid system and critical infrastructure, like pipelines, for the potential of cybersecurity attacks. This isn't something that might happen tomorrow. This is something that is happening every single day and our utilities and others are fighting against that.

When you think about it, the application of microgrids and the technology of microgrids is another example of how you maintain services if those kinds of attacks happen, the microgrids can build some insulation and some security layers into the system. So I just encourage you to continue to pioneer this technology.

Regional energy solutions should be a priority for our nation. And the reason that is so clear to me here in Alaska today is because these solutions help build a robust system that takes advantage of our national labs, and I am so glad our labs are here today, together with academia and the private sector. These are the peo-

ple who are going to take these ideas and commit them to real life action and we need to continue to make progress on them.

I have been a strong proponent of performance metrics for microgrids and investing in matching federal dollars to help increase the grid resilience. We were proud to work together, as my colleague said, on the energy bill to tailor the needs to places like Cordova, and also places like Anchorage and Seattle, so that the interconnectedness is there. But we are also exposed to natural disasters, forget cybersecurity for a minute. Natural disasters can happen and the notion is that we need to have a strategy. I think both Alaska and Washington get this very clearly, about how the grid can be disrupted and what we would need to do to set up a system to help build more resiliency for our states. I look forward to hearing from all the witnesses here and to hear the input and suggestions as we continue to deal with this issue at the national level.

I would be remiss if I didn't mention—I do not get to stay for this big celebration tonight, but maybe in the future I could come back. I certainly support the efforts of science in the marine area that is going strong here in Cordova. As a member of the Commerce Committee, I'm focused on the upcoming reauthorization of Magnuson-Stevens. It is very important that we continue to have great science applied to our fisheries, and I look forward to working with the community on those issues.

I feel so excited to hear from our witnesses today. Again, Mayor, thank you for delivering. I see that might also be a parting gift that I will definitely take——

[Laughter.]

I thought it was only one. I thought we were going to have to fight over it.

[Laughter.]

Okay, I am happy now.

[Laughter.]

Thank you, Madam Chair.

The CHAIRMAN. Thank you, Senator Cantwell.

It is always about the fish.

[Laughter.]

But just thank you, thank you for being here and for your leadership on this and the recognition. I think it is important for those who are attending the hearing this morning and those who will later read the record, to understand how much Alaska is pioneering.

When you repeated the statistic, 12 percent of the hybrid microgrids in the world are here in our state—sometimes I think we do not think that we are being that innovative or pioneering. We just figure things out. And sometimes we say, gosh, we just did that with a little duct tape and made it happen. But I think what we need to be reminded of is that others are looking. They are watching. They are trying to learn from us. And that, hopefully, is very empowering to each of you. It certainly is to me.

Mayor Koplin, we are going to ask you to lead off the panel. Mayor Koplin, of the City of Cordova. He will be followed by Dr. Abraham Ellis, who is the Principal Technical Staff at Sandia National Laboratories; Ms. Gwen Holdmann, who is the Director for

Alaska Center for Energy and Power; Meera Kohler, Chief Executive Officer for Alaska Village Electric Cooperative; and Mr. Geoff Larson, CEO and Co-Founder of the Alaskan Brewing Company.

For those who are not familiar with how a Senate hearing is conducted, we ask each of our witnesses to provide their oral testimony, trying to limit it to about five minutes or so. Your full statements will be included as part of the record. When each of you have concluded your remarks, Senator Cantwell and I will begin a series of questions, going back and forth.

We will allow for the record to be kept open so that if you would like to supplement, or if we have additional questions, it does become part of the full Committee record. So even though we are not conducting this in Washington, DC, it is being recorded and transcribed as part of the full Committee record for the Energy and Natural Resources Committee.

Mayor, thank you for having us in your beautiful community and thank you for your leadership in so many different areas.

STATEMENT OF HON. CLAY KOPLIN, MAYOR, CITY OF CORDOVA, ALASKA, AND CEO, CORDOVA ELECTRIC COOPERATIVE, INC.

Mr. KOPLIN. Thank you, Senator Murkowski and Ranking Member Cantwell. It's good to have you here this morning.

As Senator Murkowski mentioned I am Clay Koplin, Mayor of Cordova, Alaska, and CEO of Cordova Electric Cooperative (CEC). We welcome you to the City of Cordova and the ancestral homeland of the Native village of Eyak. We're so pleased to engage in this exciting conversation.

Cordova really is an ideal location for having this discussion about street-smart innovation, resilient microgrids and hybrid energy systems that characterize many of our more fortunate Alaskan utilities and the communities they serve. We really do excel at innovating, at marshalling lean resources and integrating unlikely and seemingly incompatible technologies into our energy systems, often improving the products and the applications in the process.

My primary focus this morning is going to be on the innovation piece, kind of with the backdrop or context of CEC's hybrid microgrid system.

So how can we accelerate innovation and improve the development and operation of microgrids and hybrid energy systems? I think it revolves around three opportunities. One, we need to increase the prominence and the participation of the innovators on the low end. And please carry that message back to Bill Gates. I've read through all their materials and they're, kind of, missing the little guys. Continue to fund the national programs and the departments in our national laboratories and their important roles, and bring industry and government closer to the problem, like you're doing today actually, before the solutions are developed so that we, as the end users and innovators, can weigh in and be a part of that process as it's happening.

Two weeks ago, CEC and Meera Kohler co-hosted a Canadian off-grid utility association's biennial meeting right here in Cordova. Gwen Holdmann also attended that event, as did an engineer from Greenland's utility, Nukissiorfiit. And on Gwen's recommendation

to the U.S. State Department, I was able to travel to Greenland last October and share some of the best practices that we've developed right here in Cordova. They're now operating one of their hydro projects at well above its rated capacity because we figured out how, with our 100 percent underground power lines, to leverage our good power factory here in town to get more out of our equipment with a manufacturer's concurrence and warranty. So we shared that with them.

Alex Hagmueller, one of the neighbors right down the street from me in Cordova, who was born and raised here, grew up working in local machine shops and commercial fishing before he decided to go back to Oregon State University and pursue his mechanical engineering degree. And while he was there he joined his friend, Max Ginsberg, and founded AquaHarmonics in designing a wave energy generator in their garage, out-of-pocket, and ultimately won the Department of Energy's $1.4 million Wave Energy Prize.

Alex is a product of his environment, and we need to support and strengthen these rural ecosystems and their role in innovating, just as the Wright Brothers did from their bicycle shop, and as Hewlett and Packard, and Jobs and Wozniak did from their garages.

In 2004 we had a submarine cable that goes north out of town here to our Humpback Creek project that was damaged in a weather event. We used a car battery and a hand-held voltage meter to pinpoint that fault in a three-and-a-half-mile long cable to within ten feet, and we repurposed and recycled wire reels and used local boats and divers and careful logistical planning to cut and slice and repair that cable and put it back in service. And it's still operating today—under $60,000, less than three months, and a conventional repair would have easily cost $1 million and taken over a year, resources we just don't have.

So how does this innovation happen and what's the end result? The right people in the right place at the right time with the right partners. We're really fortunate that many of our staff at Cordova Electric were born and raised here in Cordova, went elsewhere to get their technical skills and their educations and then they brought it home. That's where our capacity and our leadership on the forefront of this energy transformation is derived from. Our core strength is our people and what they do and how they do it. So we need to build on that momentum and use the lessons learned to benefit communities and industries across the country more broadly.

We at CEC continue our march toward a full smart grid capability with 100 percent local renewable sourcing of our local energy supplies. This will someday allow distributed generation, energy storage, home appliances, electric vehicles, businesses and industrial equipment and lighting to electronically and automatically communicate with our own high capacity energy supply system. That's really what smart grid is going to look like, and that's how we can allow renewable energy to be deployed when its available and to charge those storage devices and then discharge and kind of go into hibernation when it's not available. The whole system becomes flexible and interactive based on the technology platforms that are being developed.

The National Renewable Energy Lab recently met with the Native village of Eyak. I'm glad to see Daryl and the Tribal Chairman here. They came to Cordova, and after a quick dialog with the Native village of Eyak, said, you know what? You are not a candidate for technical support. You are a candidate for a best practices hearing on our part. They came out here and spent four days picking our brains and trying to figure out what's the secret sauce that you have going here? And a lot of it just boils down to really working together within the community here, as organizations, to move the ball forward.

One of those two staff decided she wants to do her sabbatical here in Cordova, and I hope she can. Both of them looked around and said, really, this can be a National Lab outpost—you have the infrastructure, and human and organizational capacity to really contribute. So we need the technology outpost like that in Alaska where we can return at least as much benefit to the partners and the industries and the governments that we work with as we derive from it.

Alaskans face such a challenging environment with such limited resources, similar to Washington, as you mentioned, in many ways, which is why we have to collaborate. It's why I sit on the ACEP's Board of Directors. It's why I work with Meera with the Statewide Utility Managers group and join her in sitting on as many national organizations, Board of Trusteeships and places as we can to bring that technology back and learn how we can collaborate better.

The energy storage project that we're currently working on with the Alaska Center for Energy and Power and Sandia National Labs is really exciting and it's a perfect example of how we marry that high technology to that, kind of, street-smart innovation and take us all to a better place.

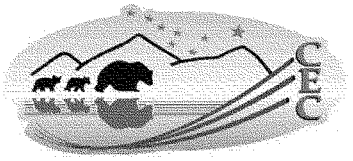
When Rob Royce, who is out in the audience here with ABB, talked to me a few months ago about Cordova maybe being a smart grid demonstration city for ABB, I got really excited but we have to figure out how to make that happen. We have to give Rob the tools to be able to go back to his corporate leadership and say, hey, not only does Cordova have the capacity to pull something like this off, but you have the support at the state and federal level to stand behind this and make something cool happen and move us all forward.

I know ABB will walk away a better company, with better products and better applications than they came here with, but we just have that same challenge of showing them and getting them visibility to what we do and how we do it.

Thank you for this opportunity to testify. I really encourage any questions you have to ask here at the end or through the questions for the record and strongly encourage you to support the investments and partnerships in Alaska and Cordova and other organizations within the state where we've already established a really good foundation from which we can build a bright future.

Thank you.

[The prepared statement of Mr. Koplin follows:]



CORDOVA
ELECTRIC
COOPERATIVE, INC

Written Testimony of Clay Koplin
CEO of Cordova Electric Cooperative, Inc. and Mayor of Cordova, Alaska
On behalf of Cordova Electric Cooperative and The City of Cordova
Before the Senate Energy and Natural Resources Committee
Hearing to Receive Testimony on Innovation in Action, Microgrids and Hybrid Energy Systems
10:00AM, Saturday, June 10, 2017

Good morning Chairman Murkowski and ranking member Cantwell. I am Clay Koplin, Mayor of Cordova, Alaska and CEO of Cordova Electric Cooperative (CEC). Cordova is an ideal location for witnessing the street-smart innovation, resilient microgrid architecture, and hybrid energy systems characteristic of many Alaskan electric utilities, which represent approximately 12% of the world's microgrids. I have lived in Cordova for nearly 19 years, the bulk of my professional career, and I am constantly impressed by the creative, persistent, can-do initiative of this community, and the successes that have resulted from that pioneering spirit. This beautiful facility that we are meeting in is just one example of years of planning, strategizing, and executing a vision to achieve a dream of a main-street community center that serves a wide range of community needs. Last week CEC joined Meera Kohler of Alaska Village Electric Cooperative in hosting the Canadian Off-Grid Utility Association's Prime Power Diesel Inter-Utility Conference, a biennial Canadian conference that for the first time in their 50-year history met outside of Canada. They were seeking relationships with Alaskan utilities that have raised the bar for integrating renewables into our microgrid systems. Gwen Holdmann also attended that event on behalf of the Alaska Center for Energy and Power, an arctic energy skunk works that has been a leader in Alaskan innovation around their technology laboratory and team.

Just down the street from my home here in Cordova are my neighbors, the Hagmueller family. The son Alex pursued a career as a diesel mechanic and worked in and around the fishing industry. He worked in a boat fabrication shop, as a diesel mechanic on shore and at sea, and as a commercial fisherman. He decided to advance his career by returning to university in Oregon where he pursed a mechanical engineering degree. He observed wave energy generator design and testing in progress at the university laboratories and decided to partner with Max Ginsberg to found Aqua harmonics and pursue a dream of developing their own wave energy generator. They worked out of pocket from their garage. As they finished building their prototype, they realized that they would not be able to afford the fees for access to a wave energy testing lab. When they became aware of the U.S. Department of Energy's (DOE) wave energy challenge, which offered finalists device testing access for proof of concept, they joined the competition against a field of 96 teams. This winter and spring, Aquaharmonics won the $1.4 million dollar DOE prize against teams that were better staffed, were better funded and supported by universities and industry, and had a longer development timeline than Max and Alex. The Aquaharmonics device not only met the DOE threshold of doubling the ratio of electric output to device cost ratio of the current leading technology, but smashed it with a five-times multiplier with their simple, functional design. They are now gathering partners and pursuing commercial development of their technology to pioneer a new generation of wave energy technology. This success is a tribute to the Department of Energy and to innovation on the low-end. But despite a national history of back-lot, neighborhood garage, and farmyard innovations from iconic innovators like Wilbur and Orville Wright, Harley and Davidson,

Hewlett and Packard, Jobs and Wozniak, I fear that we are currently overlooking the successes of the small contributors on the fringe. Out here on the bleeding edge of the energy frontier, the practical and affordable solutions developed by the survival-driven players can complement the world-class universities, corporations, and national laboratories which work from an entirely different resource base and paradigm.

Here in Cordova, a submarine transmission line from Cordova Electric's remote Humpback Creek Hydroelectric Project was damaged by a delivery barge dragging their tow chain on the ocean floor in 2004. CEC used a simple but effective fault locating method developed by two Alaskan electrical engineers in the 1970's to precisely locate the fault in the three and a half-mile long cable using nothing but a car battery, jumper cables, and a 30-year old voltage meter. The cable was repaired using local fishing vessels, divers, and linemen at a cost of under $60,000 over three months. A conventional repair would likely have approached $500,000 and taken up to a year to execute. There are hundreds of examples of similar innovative solutions that Alaskan utilities apply to their daily challenges and frankly we need to be capturing them.

So how does this innovation happen and what is the end result? Here in Cordova we will have the opportunity to show you the 100% underground power lines that result in some of the highest system reliability in the country. Cordova's 100% LED street lighting saves thousands of gallons of diesel fuel and tens of thousands of dollars in energy bills annually while reducing light pollution and improving air quality. Later today we will tour Power Creek Hydroelectric plant; a run-of-river hydro project that provides 60% of the community's electric energy annually. The fully automated and remotely operated Humpback Creek Hydroelectric project contributes 15% of the community's power annually and joins Power Creek in keeping the grid on 100% renewable energy over half of the time. The remaining one-fourth of the community's annual energy needs are provided by the Orca diesel generation plant.

These energy system assets and attributes are impressive given the remote, logistically challenging, resource-constrained environment and daunting economies of scale of our community of 2,300 residents. Perhaps more noteworthy, however, are the agile and innovative processes applied to the development and operation of this system. Many Alaskan electric utilities combine key ingredients of innovation; necessity, collaboration and marshalling of community resources, broad and practical skillsets, and an agile trial-and-error "fail forward" approach fueled by an optimistic belief that solutions exist if we can discover them. Simple, practical, and affordable solutions evolve organically in our frontier laboratory microgrid systems. Here, innovation is a live-fire exercise from which we don't leave the field of battle until the lights are back on. In a recent assessment of Alaskan utilities and their capabilities, Peter Larsen, PhD, of Lawrence-Berkeley National Laboratory (LBNL) characterized Cordova Electric and a handful of other Alaskan utilities as "leaders and innovators". National Renewable Energy Laboratory (NREL) staff worked with the Native Village of Eyak (NVE) this April to evaluate the Cordova Renewable Energy Working group (CREW) and their successes. The CREW was founded by NVE and CEC in response to the energy and economic crisis of 2008. NREL concluded that Cordova can serve as a best-practices model and is a compelling site for a national laboratory outpost. This would marry the high technology of universities, national labs, and industry to field applications that refine and improve the technologies as they are integrated into the micro grid.

I want to underscore the importance of partnering. Cordova has organized many collaborations between utilities, the tribes and native corporations, NGO's, state and federal agencies, and the City. The soft technologies of planning, coordinating, and structuring these relationships and partnerships are often more critical to success than overcoming the financial or technical barriers.

Our hydro-diesel hybrid microgrid system operates on a highly automated, "smart grid" platform that maximizes the production of renewable hydropower and minimizes the use of diesel fuel. This improves economics and system reliability. The system is far from perfect, however, and our work is far from done. Several projects currently in progress will reduce diesel fuel use and build capacity and resiliency in the grid to move toward a fully automated and integrated smart grid. A smart grid will store excess energy or operate customer appliances and applications when renewables are available, or draw from storage and minimize customer use when renewables are not available.

CEC has just completed a joint effort with Sandia National Laboratories and ACEP that used over a decade of high-resolution data from CEC's automation system to model energy storage on the Cordova grid. Adding energy storage will result in a sharp reduction of diesel fuel use and improved operating quality of the system. A request for proposals for implementing this storage project will consider alternatives for utility, tribal, private sector, or public partnerships on the commercial side, and various technologies for energy storage.

In my March testimony on infrastructure to this committee, I briefly discussed the Crater Lake Water and Power project. A Federal infrastructure investment in this shovel-ready water and renewable energy supply project to Cordova would result in the water and energy needed to create direct and supporting jobs, economy, and improved national trade balance for our growing fishing industry.

This year we are implementing fuel-saving energy efficiency improvements to our Orca diesel generation plant and deployment of electric vehicle and charging stations in Cordova. We are now researching variable-speed generator technologies and ultra-capacitor energy storage devices showcased at the Canadian off-grid conference in Cordova last week. We are working with our communications partner Cordova Telephone Cooperative to evaluate installation of fiber optic cables in existing, active, power supply conduits. This has been successfully practiced by Anchorage utilities to better utilize existing infrastructure, and would provide a necessary building block for full smart-grid capabilities. We are working with industry partners like Schweitzer Engineering Labs and ABB to continue our march toward full smart-grid capability and 100% local, renewable sourcing of our energy supply.

Our electric vehicle initiative is currently contemplating a partnership with the US Air Force (USAF) and local GSA partners Native Village of Eyak, City of Cordova, US Coast Guard, and US Forest Service to conclude a USAF pilot project to evaluate grid charge and discharge of electric vehicles. ACEP is facilitating the partnership. CEC's microgrid offers the opportunity to test this capability and cold-weather performance of the vehicles, while building smart grid and storage capabilities and expertise for CEC. This also provides the opportunity for Cordova and Department of Defense and military branches to start partnering to develop remote and micro-grid applications on which we both rely. The US Coast Guard is currently considering Cordova as one of a handful of potential sites to deploy two new fast class cutters. We feel that our local grid capabilities and energy initiatives complement our low exposure to tsunamis, our top ranked public safety and schools and our proximity to Alaska pipeline oil tanker lanes and the largest commercial fishing fleet in the state of Alaska as an excellent location for Coast Guard assets to live and work in performing their mission of protecting our coastal communities and environment.

In summary, Cordova and other Alaskan utilities, tribes, organizations and partners are a unique contrast of need and capability that rely on the technical innovation and financial partnership of federally supported programs and projects. In return, we can deliver multiple value streams back to the Federal Government and industry partners.

Thank you for this opportunity to testify. I would encourage any questions you might ask, and strongly encourage you to support investments and partnerships in Cordova and other Alaskan opportunities where we have already established a foundation from which we can build a bright future.

Respectfully,

Clay Koplin

The CHAIRMAN. Thank you, Clay. It is good to be in this technology outpost. I never really thought about it that way, but here we are in the technology outpost of Cordova, Alaska.

Dr. Ellis, tell us how the national labs fit in with so much of what is going on. I think you had a great segue there from the Mayor.

STATEMENT OF DR. ABRAHAM ELLIS, PRINCIPAL TECHNICAL STAFF, SANDIA NATIONAL LABORATORIES

Dr. ELLIS. Absolutely.

Let me start with saying good morning and thank you, Chairman Murkowski and Ranking Member Cantwell, for the invitation to share my perspectives about this very important topic of microgrids and hybrid energy systems.

I'd like to commend the Committee for the location of choice. I'm looking forward to tasting the good salmon here. Haven't had a chance yet, but the reputation precedes you here, so that's awesome.

Cordova certainly exemplifies, as the Mayor says, the magnitude of the challenge that we have to deal with to meet the energy needs of remote communities but also exemplifies what is possible when the right stakeholders come together to work on a sustainable solution.

As we learn more about Cordova's success stories today, I think it's very important for all of us to remember that many communities here in Alaska and across the world have struggled with meeting their energy needs every day.

Today what I'd like to do is convey three messages. The first one is that microgrids represent still, a very complex technical challenge with significant unresolved technical questions that really merit additional research and development. Second, I'd like to say that microgrids have been and will continue to be a really effective incubator for new technologies that are useful for the grid. And third, advancements of microgrids not only support the needs of these remote communities and island communities, but they are also an important ingredient to national energy resilience and they're also drivers for grid modernization.

Let me share with you a little bit of my own personal and professional experience with microgrids. I grew up in a small town in Panama, actually, isolated from the grid, where electricity evolved there in that town in much the same way as I imagined it did here in Cordova. It started with a few diesel generators in stores and coffee processing plants. Eventually we added a hybrid electric plant and a small distribution grid.

The benefits for us, as you can imagine, were very broad and immediate. However, even though electricity was, you know, expensive and unreliable, it was very welcome in the community. It was very difficult. We struggled, actually, with maintaining the system, keeping it operational and then planning for growth for the future, always a challenge.

My first job, that's 25 years ago or so, promoted sustainable rural electrification in Latin America. There I met some people that actually worked with Meera Kohler until now, so that's a small world, isn't it? And this is like Guatemala and Southern Mexico.

Even though the cost was very high, even then, it made very, very, good sense to demonstrate the use of solar and wind power for critical applications in the community like water pumping and refrigeration. A few of the larger communities chose to work with us to add renewables and storage to their diesel plants, which resulted, you know, back then with some of the earliest hybrid systems in operation, successfully.

These early efforts, some of them led by Sandia and other national laboratories, demonstrated the feasibility of drastically reducing diesel fuel consumption while keeping the lights on for longer hours. We also documented some of the key challenges that really makes sustainability and replicability difficult. And the first one was initial cost. It continues to be an issue today, even though the benefits in the long run are greater, the initial cost is a huge barrier. Second is technology readiness. It was problematic at that time. Off-the-shelf electronic equipment, things like storage systems, degraded and sometimes failed faster than expected due to the very difficult operating conditions, high humidity, temperature swings, things like that. Possibly the most challenging issue was institutional and human factors, actually. That was an eye-opening lesson learned for me. These included things like the lack of business models, poor access to technical expertise and support, financing, all of these complicated by very difficult logistics in remote communities.

I am sure that my colleagues in Alaska will attest to the fact that these difficulties that we encountered so many years ago are still very relevant today. Significant progress is being made; however, here in Alaska, they are supported by entities like the Alaska Center for Energy and Power, working hand-in-hand with communities and utilities. Because the cost of remote energy, as Senator Cantwell said, is high in these communities, it makes good sense to consider new technologies that may not be economically viable in other places.

A similar set of conditions is driving the adoption of microgrid and hybrid system technologies in places like Hawaii, DoD forward operating bases and other remote mission critical installations.

Here I want to emphasize that remote microgrid developments are also paving the way for modern national grid advancements. Fundamentally, the same technologies used in remote microgrids are being deployed within the larger interconnected power system. In that context those technologies are delivering cost savings for consumers. They're also delivering improved energy resilience for applications like transportation, communications and so on.

There is a lot to be done still. Microgrids can be more reliable, more affordable, more scalable. Advanced microgrids, as the Mayor said, can help us integrate higher quantities of renewable energy and distributed energy resources and can contribute to that secure and resilient national grid.

To achieve this vision, there is a need to further develop and, you know, push forward, the underlying technical or the underlying technologies such as energy storage and power electronics. We still have work to do there. Controllers and protection systems are particularly important in this setting.

We also need better methods, models and tools to support optimal design and operation of these systems. And we also need those kinds of tools to guide investment and even policy decisions.

Finally, more work is needed to shepherd the orderly evolution, and this is a big one, of technical standards that will allow microgrid components to interact safely and securely with each other with utility systems and with energy markets of the future. This work involves complex, as I said, technical, institutional and human factors.

The Department of Energy and National Laboratories are playing a critical role in this space. It makes a lot of sense as this is a challenge of national importance.

In closing, let me reiterate remote microgrid technologies for the benefit of Alaskans also has the potential to enable a more modern, secure and resilient national grid. This Committee is very aware of the impact that investments in energy technologies have had over time. One example that is often brought up is Sandia's advanced drilling technology, which has been reviewed by this Committee in the past. In my opinion, microgrid research and development will have an even greater impact nationally.

With that, I'll say thank you very much, again, for your attention, and I look forward to your questions.

[The prepared statement of Dr. Ellis follows:]

US Senate Energy and Natural Resources Committee Field Hearing

Cordova, Alaska – June 10, 2017

Testimony of Dr. Abraham Ellis, Sandia National Laboratories

Good Morning. Chairman Murkowski, Ranking Member Cantwell, and Members of the Committee, thank you for the opportunity to share my perspectives on the important matter of microgrids and hybrid systems. I'd like to commend the committee for choosing Cordova, Alaska for today's discussion. Cordova clearly exemplifies the magnitude of the challenge to meet the energy needs of remote communities, but also what is possible when stakeholders work together to find a sustainable solution. As we learn more about this subject and hear about Cordova's success story, it is important to remember that access to energy is a daily struggle for many other communities in Alaska and elsewhere.

The key messages I'd like to convey today are:

(a) While microgrids are not a new technology, they represent a complex system-level challenge with significant unresolved questions that merit research and development.
(b) Remote microgrids have served as an incubator of new grid technologies in the past, and will continue to be a catalyst for innovation.
(c) Advancement of microgrid technologies supports a continuum of major needs, from remote power to energy resilience and national security.

Definitions

- A ***microgrid*** is a group of interconnected loads and distributed energy resources (such as renewable generation and storage) within clearly defined boundaries that acts as a single controllable entity. A microgrid can connect and disconnect from the interconnected grid to enable the microgrid to operate in both grid-connected or island mode. Many universities and large businesses operate microgrids that have this flexibility.
- A ***remote microgrid***, also known as a ***mini-grid***, is a microgrid that does not have the possibility to connect to a larger grid, and thus operates in island mode all the time. Legacy remote microgrids typically rely on diesel generators, but new installations and retrofits increasingly include storage and renewables. Examples of remote microgrids include island, remote community power systems, oil platforms, and forward operating bases.
- A ***hybrid power system*** is a microgrid that combines diesel generators with renewable energy generation such as wind, solar or hydro, as well as energy storage.
- An **interconnected grid** is a large and complex network of synchronized power providers and consumers that are connected by transmission and distribution lines and operated by one or more control centers. Most large interconnected grids started as a collection of independent microgrids.

I would like to share with you a bit of my personal and professional experience. I grew up in a small mountain community isolated from the grid, where electrification evolved in much the same way it did in Cordova. We started with small diesel generators in stores and coffee processing plants. Electricity was expensive and unreliable. Eventually, we added a hydroelectric generator and small distribution grid. The benefits were broad and immediate, but we quickly learned the difficulties of maintaining the system and planning for growth. In retrospect, my life work has been motivated by growing up in a time and place where electricity is a precious resource.

My first job, almost 25 years ago, promoted sustainable rural electrification in Latin America. Even though the cost was high, it made good sense to demonstrate the technical viability of solar- and wind-powered water pumping and refrigeration. In a few larger communities, we added renewables and storage to existing diesel systems, which resulted in some of the earliest remote hybrid systems in operation. These early efforts, led by Sandia and other national labs, demonstrated the feasibility of drastically reducing diesel fuel consumption and keeping the lights on for longer. Renewable energy is a good fit for remote communities that tend to be located in environmentally-sensitive areas. We also encountered and documented key challenges for future sustainability and replicability:

1. ***Initial cost*** – Few could afford the high initial cost, even if the benefits in the long run were greater than the cost.
2. ***Technology readiness*** – The operating conditions were more challenging—high humidity, temperature swings, salt spray, and even insects! Off-the-shelf electronic components and batteries failed or degraded sooner than expected.
3. ***Institutional factors*** – These included the lack of business models, lack of access to technical support and financing, complicated by difficult logistics.

Why Pursue Microgrids Developments in Alaska and Elsewhere?

That brings us to today and all the work that has been done in Alaska, home to many remote microgrids. I am sure that my colleagues will agree that we have made monumental progress over time, but many

Examples of Alaska Microgrid Projects with Sandia Participation

- **Cordova Energy Storage Project –** Sandia is collaborating with the Cordova Electric Cooperative (CEC) and the Alaska Center for Energy and Power (ACEP) to investigate the feasibility of using energy storage to reduce diesel fuel consumption and make optimal use of existing hydro generation. The basic concept is that the energy storage system will provide contingency reserve capacity, deliver more low-cost hydro energy to the load, and extend the period of time when the system can operate in "diesel-off" mode. This project will result in an energy storage system deployment planned for 2017.
- **GMLC Alaska Regional Partnership –** DOE funded a team of national labs led by NREL and including Sandia, partnered with several Alaska-based partners including ACEP, to help remote Alaskan community microgrids reduce imported fuel by 50%, taking into account electricity, heat and transportation. The involves assessing of energy needs, improving energy information, and outreach to promote private and public engagement. The project also includes designing model remote microgrid pilot projects in Chefornak and Shungnak.

significant challenges remain. The efforts being undertaken here are breaking new ground and are making a difference for many Alaska remote communities, many of them Alaskan Native. Because the cost of energy is very high, it makes sense to consider new technologies that are not yet economically viable elsewhere. A similar equation is driving adoption of advanced microgrids and renewable energy integration technologies in Hawaii and at DOD installations and forward operating bases.

An Example of High Return on Investment

Solar, wind power, energy storage, and associated power electronics and control systems matured in great measure due to application experience in remote microgrid and hybrid systems.

I want to stress that remote microgrid research, development and targeted demonstrations are also paving the way for new grid technologies that will modernize our national grid. Fundamentally, the same technologies used in remote and island microgrids are being deployed within the larger national grid, delivering cost savings as well as improved energy resilience for security, transportation, communications, health and other critical services. That is why the Department of Energy national labs are involved. With DOE leadership and funding, Sandia and its fellow national laboratories have been proud to spearhead the R&D in underlying technologies that are making advanced microgrids more viable.

We have a vision of microgrids that are reliable, affordable, sustainable and scalable. Microgrids can enable higher penetration of distributed and renewable resources, including smart buildings, energy storage and electric vehicles, and make the grid more secure, efficient and resilient. To achieve this vision, there is a need to further develop energy storage, controllers, protection and cybersecurity systems. Better planning and operations methods are needed to achieve the full potential of microgrids and distributed energy resources. There is a need to develop and validate new design tools and

Microgrids and National Security – Two Success Stories

- ***Military Applications*** – Sandia played a principal role in the Smart Power Infrastructure for Energy and Reliability and Security (SPIDERS) JCTD, a groundbreaking program to bolster the cyber security and energy efficiency of U.S. military installations and transfer the knowhow to non-military critical infrastructure. Sponsored by DOD, DOE and DHS, the SPIDERS JCTD focused on four elements for enhanced national-security power surety: (a) Protect task critical assets from cyber-attacks, (b) Sustain critical military operations during prolonged power outages, (c) Integrate renewable and other distributed energy generation, and (d) Manage electrical efficiency to reduce petroleum demand, carbon "boot print," and cost. The program included demonstrations at three different sites: Pearl Harbor-Hickam, Hawaii; Fort Carson, Colorado; and Camp Smith, Hawaii (DOD's first installation-wide microgrid).
- ***Critical Civilian Infrastructure Applications*** – Major tropical storms pose a high risk to critical infrastructure on the East Coast of the United States. In 2012, Superstorm Sandy caused extensive damage in New Jersey and New York, and the resulting electrical outage severely hampered recovery efforts and put lives at risk. At the request of DOE and in partnership with NJ stakeholders, Sandia applied methods and tools previously developed in the SPIDERS program to define and optimize energy resilience options for the City of Hoboken and for the NJ Transit system serving Northern NJ and NY City. Both projects resulted in the conceptual design of a microgrid that could provide energy for critical services (hospitals, shelters and rail/ferry/bus service) in the event of a power outage caused by a major storm, cybersecurity attacks, or other events. The City of Hoboken is presently exploring options to finance its microgrid. The NJ Transit microgrid is presently under construction.

performance metrics to guide investment decisions and to inform policy. Finally, more work is needed to guide the orderly evolution of technical standards to ensure that microgrid components can interact safely and securely with each other, with utility systems, and energy markets.

This work is complex and must consider technical and institutional factors. And it requires close coordination with industry, as well as with tribal, municipal state government, and other local stakeholders such as the Alaska Center for Energy and Power (ACEP).

Conclusion

Thank you again for the opportunity to share my testimony about this important topic. I believe that advancing remote microgrid technologies not only supports the immediate needs of remote and island communities, but also supports the goal of a more secure and resilient electricity supply for our national grid. Public sector investment plays a critical role to ensure that microgrids reach their full potential as an enabler of grid modernization. I know this committee is familiar with the major economic impact driven by the Sandia Polycrystalline Diamond Compact (PDC) drill technology. In my opinion, investment in microgrid research and development has the potential to make an impact at a similar or larger scale.

Thank you very much for your attention and I look forward to your questions.

The CHAIRMAN. Thank you, Dr. Ellis.
Ms. Holdmann. Welcome, Gwen.

STATEMENT OF GWEN HOLDMANN, DIRECTOR, ALASKA CENTER FOR ENERGY AND POWER, UNIVERSITY OF ALASKA FAIRBANKS

Ms. HOLDMANN. Thank you.
The CHAIRMAN. You are the only one that I know that came to the hearing today by sailboat.
Ms. HOLDMANN. That's right.
[Laughter.]
Thank you.
Thank you, Chairman Murkowski and Ranking Member Cantwell, for the opportunity to be here this morning.
I direct the Alaska Center for Energy and Power, and we play this unique role. We're based at the University of Alaska Fairbanks, but we work really closely hand-in-hand with our communities and utilities to make sure the kinds of technologies, that they're aware of these next generation emerging technologies, and we're working with them to try to make sure that they are adapted in ways that are going to meet the kinds of goals of reducing energy cost and increasing reliability and resiliency of our small grids here. On the other hand, we're working with developers and industry to try to make sure that their technologies are developed in such a way that they are going to be appropriate and are going to be successful and resource a small grid environment. We have a laboratory at the University of Alaska Fairbanks, so they do a lot of testing of technology before we try to move it into the communities where it can be deployed and taken advantage of by our utilities and our residents.
You know, I really appreciate the fact that Senator Murkowski has done such an excellent job in advocating for Alaska's excellence in terms of microgrid technologies. I think it's been mentioned here several times that Alaska does have more microgrids than basically anywhere else in the world that has grid-scale renewables connected to them.
One of the things I want to highlight is that a lot of that expertise that Alaska has in terms of developing these sorts of systems, really resides within our utility industry here in Alaska. And so, I'm really happy to be here with both Clay Koplin and Meera Kohler, who are really two of the people that, I think, are really leaders in the way that our utilities are creatively adapting new technologies and new ideas and really looking for what the energy grid of the future is going to look like, what the systems of the future are going to look like.
I also appreciate that Senator Cantwell pointed out the fact that we're not just talking about these unique, small situations in Alaska, but that this really does represent the way that we are going to transform the electric grid and the rest of this country in the future too, which will be around greater integration of renewables, more distributed generation and just trying to form these microgrids that enable more resilient and reliable grid infrastructure across the country. I do agree with you that Alaska is really

that place where we're pioneering a lot of those technologies that will get us there.

The world has been more and more recognizing that Alaska is doing some unique things here, that we're really pushing these levels of renewable energy generation like Meera is to a level that would make more utility operators pretty nervous. And they're doing that to these very, you know, kind of important strategies not just incorporating energy storage, but also demand response, looking at smart grid enabling technologies. There's a lot of things going on here that are quite interesting.

We have the Arctic Remote Energy Networks Academy. We're bringing people from all over the Arctic together to do knowledge sharing about these sorts of microgrids. We're hoping to expand that to a more global level, but we have people coming from Greenland and Canada and Russia and other places in the Arctic region that can benefit from these sorts of solutions. They're coming to Fairbanks in two weeks and then we're taking them to Kotzebue and on to Nome in that particular case. But those are examples of where Alaskans can share that expertise.

I'm also really excited to talk about some positive examples for state, local and federal collaboration. In particular, the last time that you had a hearing in Bethel, I talked about the need for an Alaska hub for energy innovation and deployment—something that we were really hoping to work with the Department of Energy on. I'm really excited to tell you that that has moved forward, not with the Department of Energy, although we hope to bring them on as a partner in the future, but with the Office of Naval Research, who has invested in Alaska to develop an energy innovation ecosystem here that goes all the way from our STEM, K through 12 education, through the development of an Alaska Network for Energy Education and Employment through REAP, all the way through funding our energy accelerator here, or our small business accelerator, the Launch Alaska program through testing and development of new energy systems at the university and then deploying those in the field.

That's a program that we're actually spinning up within the next few months, and we'll be working on for the next three years. That will give us a chance, for example, to be working with Meera on a particular system that she's identified as a need for her community which is the small amounts of energy storage, a grid bridging system that will enable her to, in an economical way, integrate both more renewables or just save fuel by switching more efficiently between smaller and larger diesel generators which are still going to be the backbone of generation of rural Alaska for some time to come. So that funding is allowing us to seek external partners to, kind of, find those perfect solutions moving forward.

My colleague here from Sandia National Lab, Dr. Ellis, also mentioned this project that we have through the Office of Electricity. This is a great example, from my perspective, of state and local collaboration because the Alaska Center for Energy and Power and Cordova Electric Cooperative, we identified this potential opportunity for energy storage here around a bit of a unique paradigm for how that would be integrated here, and we pulled in expertise

through the Clean Energy SAFE Alliance and requested expertise from, specifically, from Sandia National Laboratory.

The Department of Energy responded to that request. The project is led by, and we are setting the context locally here, but Sandia National Lab is providing critical expertise to make that project happen. Those are the kinds of ways that we want to be partnering with our national labs. I think it's a really great story.

Similarly, we have a lot of regional partnerships going on. We worked really closely with the University of Washington on the Northwest National Marine Renewable Energy Center (NNMREC). So we have three universities there, the University of Alaska Fairbanks, UW and then Oregon State University that work with the Department of Energy (DOE) on this regional collaboration around hydrokinetic technologies. And we appreciate both of your long-term support for ocean and river and instream energy solutions.

I'm currently serving on the board of the University of Washington Clean Energy Institute (CEI). I'm the only person from another university that's serving in that role. And so, that's another way that we're working really closely together.

We have a program that we call the Center for Microgrid Technologies Commercialization, and it's a partnership between the Economic Development Administration and the University of Alaska. And we actually host the competition for companies that have microgrid enabling technologies to test their technology in our lab and work with our engineers with the idea of pushing it out into communities in Alaska.

So we had our first round, our first competition, and we just announced the winners a few weeks ago. And actually, UET, UniEnergy Technologies, a battery manufacturer from your region, from Mukilteo—am I saying that correctly?

Senator CANTWELL. Yes.

Ms. HOLDMANN. —is actually the winner of that particular award. We're going to be bringing their system up here to Alaska, testing it in our laboratory. I actually hope that someday we might see that system the next time you come back, actually operating here in Cordova and providing that storage solution that we've been working with Sandia to identify right now.

That's really all I have to say. I apologize for going a little bit over, but this need for driving partnerships, I think, is really important. I'm really excited to hear that you're still moving forward with this concept of an energy bill because I think that we do need an update to create that framework at the national level, but really for promoting these partnerships and really pushing the understanding of what is needed to the lowest common denominator where that's our communities and our state, that we can be pulling in expertise from the Federal Government. That's the type of framework that we're excited to work around.

So, thank you.

[The prepared statement of Ms. Holdmann follows:]

Gwen Holdmann
Director
Alaska Center for Energy and Power
University of Alaska Fairbanks

Written Testimony before the
United States Senate Committee on Energy and Natural Resources

June 10th, 2017

Thank you, Senator Murkowski, Senator Cantwell and the virtual members of the committee. I appreciate the opportunity to appear before you today. My name is Gwen Holdmann, I am the Director of the Alaska Center for Energy and Power at the University of Alaska Fairbanks. I was also recently appointed as the Director of the Office of Intellectual Property and Commercialization for UAF.

Senator Murkowski, I'd like to thank you personally for your national leadership not only on the productive use of our energy resources but for a host of other important issues facing our country. Your efforts are valued and appreciated. Senator Cantwell, welcome back to our state and thank you for the excellent work you and Senator Murkowski have accomplished by partnering on a bipartisan basis.

I appreciate the theme the two of you have selected for this Hearing – Innovation in Action, Microgrids and Hybrid Energy Systems – and I think it is very fitting we are hear in Cordova, which has been a leading community in terms of working toward solutions that will define our energy future, not just for microgrid communities like we find here in Cordova, but in ways that will also be relevant for the greater transformation of the national grid I expect we will see over the next several decades.

Of our roughly 150 communities in rural Alaska, there are about 70 projects that incorporate grid-scale renewables on community microgrids. Many are pushing penetration levels of variable renewables on a regular basis that would make most utility managers quite nervous. These are not demonstration projects. These are not pilot projects. Are they innovative? Yes. Do they work with local operators? Yes. Are they economically viable? Well, that might be a more complicated question to answer but the point is that these are examples of strategies Alaskans have adopted to provide reliable energy services in remote and harsh environments. In all, Alaska has about 12% of the microgrids in the world. Not islanded or remote systems, but microgrids in the broader sense of the definition. These have in very large part been funded by the State of Alaska, through programs like the Renewable Energy Fund and the Emerging Energy Technology Fund. Over the course of the past 2 decades, we have built up a substantial body of knowledge related to the design, construction, and operation of these systems.

When this committee last held a field hearing in Bethel, I mentioned that we are working on developing an Alaska Hub for Energy Innovation and Deployment (AHEID), where Alaska can serve as a 'living laboratory' to enable transformational change of the electric power market, with commonplace 100% renewable energy operation for microgrids - whether in U.S. markets or the developing world – using strategies that are cost effective from a holistic community perspective, addressing all energy requirements for the customers served, not only those that are electric. I am happy to report that we have made some very substantive progress in this area, and would like to present a few specific examples.

Example 1: The Office of Naval Research has recently invested in the AHEID program, funding an energy ecosystem in Alaska that incorporates not only research conducted through the Alaska Center for Energy and Power, but also the Alaska Network for Energy Education and Employment (ANEEE) managed by Renewable Energy Alaska Project (REAP) and Launch Alaska, a business accelerator specifically working on energy issues. Through this project, we will be able to work on technology development and research specifically identified as next-generation needs by Alaska communities and utilities, and by extension represent next-generation technologies with much broader applicability. For example, through this project we will be able to work with AVEC on developing a Grid-Bridging Storage Solution that they have identified as a top need and priority for their communities, as a way of economically incorporating higher penetration levels of renewable energy.

Example 2: I would like to mention the importance of our partnerships with DOE and our national laboratories, as assets to support our projects and help accelerate the development of energy solutions. Currently, ACEP is involved in four active projects that have both national lab and community involvement:

- the DOI-funded Remote Community Renewable Energy Project (Kokhanok, AK; NREL)
- the DOE Grid Modernization Program funds the Alaska Microgrid Partnership (Chiniki Wind Group, and other communities; NREL, PNNL, LBNL, Sandia; local industry and NGO partners)
- the DOE Office of Electricity funded Design Support Tool for Remote Off-grid Microgrids (Nome, Cordova, Kokhanok; LNBL, LANL, ANL, BNL; other national industry and community partners)
- the DOE OE Energy Storage Program funded Optimal Sizing of Energy Storage Project (Cordova Electric; Sandia)

All of the above, as well as several previous collaborations have been quite fruitful in moving the needle regarding reducing the cost of energy for remote communities, while increasing our understanding of detail and big picture issues that need to be addressed. I would like to specifically highlight the Cordova project given our venue. Through past projects with Cordova Electric, ACEP had identified several options for CEC to increase the utilization of their low-cost hydropower resource, while reducing the high-cost utilization of diesel generators. One of the identified options was to investigate an energy storage system to aid in this effort. In parallel, ACEP had identified a cross-cutting need for many of our remote communities to be aided in formalizing the process of *need-based* selection of energy storage systems. Both aspects were combined in a white paper pitching a study to the Clean Energy States Alliance and the DOE OE Energy Storage Program. As we knew from previous collaborations that necessary expertise resided at Sandia National Labs, it was also requested, that their Energy Storage Modeling Group were deployed in this project.

The first phase of the project, determining the optimal size of an energy storage system, as well as its operational requirements, and placement options was completed recently, with the final report to be issued by the end of June. The work identified the potential to shift about 1 GWh of electric generation annually from diesel generation to hydropower generation, which constitutes a 10% reduction in diesel utilization. The collaboration between CEC, ACEP, and Sandia was very fruitful with CEC providing necessary data and meta-data about their system, ACEP handling data processing, and model development for optimal sizing of the energy storage system, and Sandia providing a high fidelity

dynamic grid model, which was utilized in testing transient response dynamics important in placement of energy storage systems in a grid.

Example 3: The Alaska Remote Energy Networks Academy (ARENA). Recently, there has been a much greater awareness of Alaska's technology leadership in this area. One example is that the Canadian Off Grid Utility Association (COGUA) held its first ever meeting outside of Canada here in Cordova last month. A big part of the reason was to share lessons learned and experiences related to remote communities across North America. We are trying to institutionalize knowledge transfer based on the Alaska experience through a newly developed ARENA program and network. In less than 2 weeks, we will be bringing native leaders, utility managers, and community champions from across the Arctic including Greenland, Russia, Canada and Alaska together to learn from practioners in Alaska. We will bring them to visit our research laboratory in Fairbanks and visit projects in Alaska's interior as well as Kotzebue and Nome. This program is based on a similarly structured program active in Iceland, the United Nations University Geothermal Training Program, which is designed to export knowledge on Iceland's Geothermal experience to areas of the developing world that are seeking to develop their own geothermal resources. This project is supported by the Arctic Council, with co-leadership from the US, Canada, Finland, Iceland and several Permanent Participants. We are using the word 'energy network' rather than 'microgrid' because we want to be sure to include all of the ways energy we use energy – specifically, not just a focus on electric power but also heat, and we hope, transportation as well. Our long-term goal is to promote knowledge sharing among people that are in the best position to influence the future trajectory of project development in their home countries and regions. We are planning to use Alaska as a living classroom to support ARENA, with our fellows touring projects relevant to their interests and interacting directly with utilities, developers, and the communities in which these projects are based to gather knowledge that can help them make good decisions about future energy development that can displace reliance on imported diesel fuel.

Example 4: Regional Collaborations. One of the things we have been working hard to foster is greater region collaborations, particularly with the greater Pacific NW. The microgrid remote energy systems of Alaska over great potential for regional collaboration. Entrepreneurs, research institutions, government laboratories, industry and project developers are exploring the opportunities for developing technologies that address the needs for reliable, affordable and sustainable energy solutions that meet the needs of community, industry, military bases and miscellaneous critical infrastructure applications. These engage accelerators like Launch Alaska, Cascadia, and Elemental Excelerator in Alaska, Washington, Hawaii, and beyond. Accessing funding available from federal, state and private sources through the Alaska Center for Microgrid Technologies Commercialization and the Alaska Hub for Energy Innovation and Deployment components, subsystems and systems teams are developing products and capabilities broadly relevant to the global energy market.

Recently, we held a competition funded the Economic Development Administration to provide technical support and testing services to companies working on microgrid-enabling technologies. I am happy to report that Uni-Energy Technologies, a flow battery manufactuer based in Muketeo, Washington was the grand prize winner and we will be testing their system in our laboratory later this year. Perhaps in the future, we may even see this system deployed right hear in Cordova to support this microgrid system.

Example 5: Hydrokinetics. Another example of strong regional partnerships is exemplified by our work on hydrokinetic energy. Hydrokinetic energy devices generate power from predictable and forecastable waves, tidal flows, ocean currents, thermal gradients and in-stream sources and could, with the right investments and policies, play a significant role in our nation's future energy portfolio. For example, the U.S. Department of Energy has estimated that approximately twenty percent of the future electricity requirements of the states of Washington, Oregon and California could be met by marine energy resources. Hawaii and Alaska alone could satisfy nearly all future power loads with marine energy technologies. In my opinion, this is a source of energy worthy of additional research, development and testing investments by the U.S. Federal Government.

Currently, the U.S. Department of Energy's Water Power Technologies Office supports cutting-edge private sector-led research, development and deployment of new innovative hydropower, pumped storage and marine energy technologies. Stable and growing federal support for these efforts will help our country meet increasing electricity needs and also gives confidence to investors and helps attract private capital.

The University of Alaska Fairbanks is a national leader in the development of new marine renewable energy technologies. UAF, along with its partners the University of Washington and Oregon State University, co-manages the Northwest National Marine Renewable Energy Center, a competitively designated U.S. Department of Energy (DOE) Center established in 2008 with the mission of advancing marine energy technologies. The Northwest Marine Energy Center's programmatic strength derives from our integrated research, development and testing activities, collaborating with private sector industry partners and the national laboratories. NNMREC serves as a "one stop shop" for technology developers; federal, state and local regulatory and resource agencies; and community stakeholders interested in marine energy.

As part of this effort, UAF operates the Tanana River In-Stream Hydrokinetic Test Site (TRTS) in Nenana, Alaska. The TRTS mission is to help developers to demonstrate and/or improve their technology for this potentially significant global market. The Tanana River Test Site was established in 2010 for testing river energy converters and associated environmental monitoring tools and techniques as well as for demonstrating the effectiveness of infrastructure necessary for successful long term deployments of hydrokinetic energy converters in natural river conditions. The University and the State of Alaska have spent approximately $500,000 to date to develop the TRTS. The TRTS is the only permitted river test facility in the United States available to developers to demonstrate their innovative hydrokinetic technologies. Since its establishment, work at the site has contributed to the development of river resource and power assessment technical specifications as well as to the growing body of literature on in-river hydrokinetics. Despite the successful completion of numerous projects at the site, the budget crisis facing the State of Alaska means continued operation of the site and maintenance of the knowledge and skills to operate the site are in jeopardy. We are thus seeking outside sources of funding to ensure the continued operation of the TRTS.

At this point let me thank both of you for working together on legislation to reauthorize the U.S. Department of Energy's marine energy research, development and testing activities. This legislation was approved by both the Senate and the House of Representatives during the last Congress, but, as you are both painfully aware, a final conference agreement could not be reached in time to be signed into law before the end of 2016.

Senator Wyden recently reintroduced the Marine Energy Act. S. 1036 is bipartisan legislation that upon approval would reauthorize the Department of Energy's marine renewable energy research and development activities under the Water Power Technologies Office. The bill supports the development of marine energy testing facilities such as at the Tanana River Test Site or the tidal test facility being developed by the Pacific Northwest National Laboratories in Puget Sound. The legislation also authorizes funding to promote research, development and demonstration to support commercialization of this nascent renewable energy industry.

Reauthorization of the U.S. Department of Energy's marine energy research and development activities through S. 1036 is essential to providing the continued funding that this industry needs at this stage of its development. This is particularly true when you keep in mind that funding from the DOE Water Power Technologies Office is the one key mechanism to support U.S. technology developers competing against overseas companies that receive a suite of subsidies. The reality is that most marine energy companies are small businesses and not yet in a position to raise the private capital or receive the tax benefits enjoyed by more mature conventional and renewable energy technologies. This industry requires targeted investments like those that are included in S. 1036.

The legislation supports efforts in the private sector and National Labs to improve the performance, lower the costs and accelerate the deployment of innovative technologies capable of generating clean and affordable power from marine energy resources. The legislation also provides ongoing support for the National Marine Renewable Energy Centers. In total, the legislation authorizes an additional $300 million in federal funding over the next five fiscal years. A welcome investment!

Speaking of funding, let me pause and thank both of you for your excellent work on the Fiscal Year 2017 Omnibus Appropriations legislation. At $84 million, you have helped to set a new high water mark for hydropower and marine energy research, development and test funding at the Department of Energy. This is a great success!

However, the recently released budget proposal for Fiscal Year 2018 would endanger this progress. In fact, at just over $21 million, a substantial reduction from the current funding level of $84 million, would cripple the DOE Water Power Technologies Office and end any funding opportunities for companies to build pre-commercial prototypes or for the University of Alaska Fairbanks to build upon our success at the Tanana River Test Site testing those devices in a real world setting.

Continued investments by DOE in research ,development and technology advancement, along with expansion of full-scale technology testing centers, will accelerate deployment of advanced water power technologies and also give confidence to investors and help attract private capital. In addition, federal commitment to creating a robust U.S. marine energy industry will advance our national economic goals by creating high-quality employment in coastal communities, increasing long-term production in shipyards, expanding development of fleets of vessels for deployment and servicing, and strengthening the thousands of businesses that make up the U.S. industrial supply chain.

Just as other power generation technologies have historically enjoyed substantial and ongoing federal research and development support, similar investments are required to encourage private companies and universities to develop promising new water power technologies and to help them progress toward commercial viability. Strong funding in support of water power systems will reduce our nation's

dependence on foreign suppliers and create a significant opportunity to expand our economic competitiveness in this emerging clean energy sector.

Closing points

In closing, Alaskan communities live and breathe change while living in some of the most adverse conditions in the nation. This enterprising spirit establishes Alaskans as with finely honed early adopter skills, that coupled with the widespread experience in dealing with constrained resources and challenging operational conditions, can provide an excellent venue for hardening U.S. technologies prior to deployment in emerging markets. We have made great progress in this area, pulling together key stakeholders and a diverse group of partners, including National Labs, Manufacturers, Developers, the Utility Industry, Academia, and Native Alaskan organizations (technology end-users) to work together to develop the *Energy Systems of the Future*, based around microgrids and holistic 'energy networks', inclusive of technology advances, and improved understanding of the human dimension of implementing change.

The CHAIRMAN. Well said, great examples of partnership there. Meera, wonderful to have you here.

STATEMENT OF MEERA KOHLER, PRESIDENT AND CEO, ALASKA VILLAGE ELECTRIC COOPERATIVE, INC.

Ms. . Thank you.

I do appreciate the opportunity to be here. Under your tutelage, you have really pioneered, I think, a support system for rural Alaska that is second to none.

So welcome to Cordova, both to the Ranking Member and to the Chairman. I am going to take the privilege of saying that, because Cordova was my home many years ago. It was where I immigrated—I come from India; I came from New Delhi and literally moved here.

[Laughter.]

So Cordova absorbed me. They embraced me, they made me a part of them, so it will always be home. Every time I come back here, my heart is just light with joy at being back here.

But I have been in the electric utility industry since 1979. Started out here in Cordova and have been the CEO of three Alaskan utilities, a very small one in Western Alaska at Manokotak, and one of the largest ones in Alaska which is Municipal Light and Power which is the municipal utility serving Anchorage, and now Alaska Village Electric Cooperative (AVEC). I've been at AVEC for 17 years.

So my heart is very much in rural Alaska, and I have always felt that rural Alaska has something to offer the entire world. And we need to make it a quid pro quo situation.

A little bit about AVEC. We are a co-op, non-profit formed in 1967. We now serve 58 communities. The latest community that we added, actually, is about 200 miles Southeast of here. We're in Napakiak now. I now have 1,000 miles between my farthest West and my farthest East community and 800 miles North to South, so it's a very vast area. These communities are very small, average population is about 400–450 people, and the average load in one of these communities is essentially about half of a grocery store at Anchorage. So where I shop basically equips two of my villages rolled together in terms of electricity usage.

Despite the fact that Alaska is very energy rich; we have a lot of natural resources but we're actually a very energy-poor state. We sell a total of about 6.3 billion kilowatt hours in Alaska which is half, less than half, of what Sacramento sells in California. That's one community that sells twice as much as the entire State of Alaska.

So that's a very stark difference, and what it tells you is that our retail energy is very expensive. In our villages, I'm very proud to say, our best rate is $.24 a kilowatt-hour in Bethel and our highest is about $.68 a kilowatt-hour where we have to fly fuel in.

But what's happening in these villages with such communities are being held hostage to very high-cost energy. And it's not even the electricity that's so expensive, it's the heat and transportation. That's what eats their lunch, if you will. So we really are totally focused on solutions for our communities.

We do operate 50 microgrids and we serve those 58 communities. What we have been trying to do is basically create the regional energy grid that Senator Cantwell mentioned earlier. We shut down power plants. We've shut about six power plants in the last 10 years or so and we are now serving those communities through interties. And actually, I have worked with Gwen on HVDC at a micro level to try to connect more villages.

The cost of building capacity in rural Alaska is extremely high. It costs about $17,000 per service to establish utility service, which is five times what it is in the lower 48, so that puts into perspective what the costs are that we grapple with.

We have collaborated to set up some pretty unique microgrids. Gwen mentioned that we're able to do very high displacements in our villages. We have a few communities where we are displacing almost 40 percent of the diesel used for generation with wind, and that's because we have highly intelligent dispatch that we've actually created ourselves.

We have on staff, really, some of the world's most ingenious minds, I think. And so, I really welcome the national labs working with us to basically partner on solutions that are going to allow even higher penetrations of wind and of solar.

I was at a breakfast meeting with Senator Murkowski and Jay Faison at ACCF, which was fascinating, just a few weeks ago. And I, actually just before that, a month before, had been in conversation with Oklo which is developing the micro-nuclear project. I think that those are going to be what turns Alaska around.

I've always had this concept in my mind of the bubble gum machine with all these little bubble gum balls in it but contained a little nuclear fission material inside of it and creates clean, emission-free, long-lasting energy for very low cost. I'd like to see resources going into that concept.

We're working with Gwen and ONR on microgrid optimization through the grid bridge system. We believe that it truly is going to allow us to go diesel-soft in many of our communities.

We have to understand that we can be a test bed for emerging technologies. We have to have something that's more robust and that's street-ready because we can't afford to be in a situation where a community goes black because a nascent technology doesn't work. That's a life, health and safety issue. If we have a multi-day power outage in one of our remote communities, you're going to have people that are facing life and death situations as a result of those outages. So we can't afford to have that happen.

I just want to put a little plug in for the fact that, you know, you're hearing today about the urban utilities in Anchorage that are going to smart meters and they're so proud of it. Well, hell, we've had those for more than 10 years.

[Laughter.]

Every one of our villages, we have smart meters and we have virtual data and we have the ability to do innovative things.

I really appreciate you coming here to listen to us in our home and understand how unique we are and how we really need your support to help us to move further along. I think we can go to some wonderful places.

So thank you again. I appreciate the opportunity to present to you.

[The prepared statement of Ms. Kohler follows:]

Written Testimony
Submitted to the
United States Senate
Committee on Energy and Natural Resources

On

Innovation in Action
Micro-grids and Hybrid Energy Systems
June 10, 2017

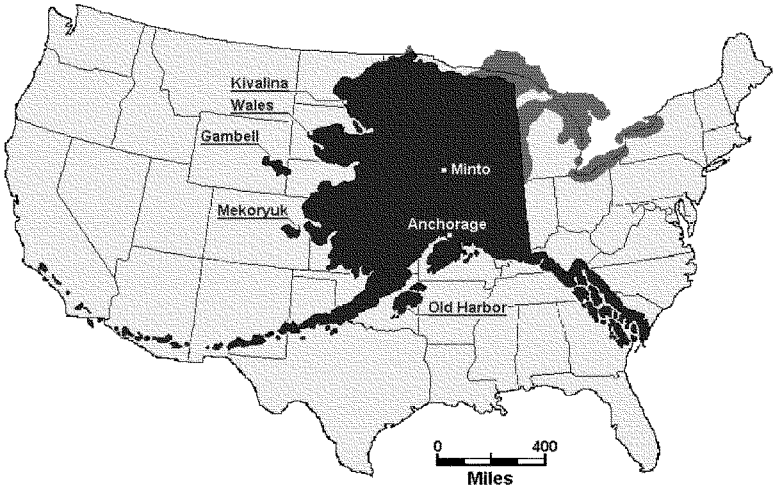
Respectfully Submitted By Meera Kohler
President and CEO
Alaska Village Electric Cooperative, Inc.

Chairman Murkowski, Ranking Member Cantwell, and Members of the Committee, thank you for the opportunity to testify on innovations occurring and sought in Alaska's micro-grids and hybrid energy systems.

My name is Meera Kohler. I am the President and CEO of Alaska Village Electric Cooperative (AVEC), a position that I have held since 2000. I started my career in the Alaska utility industry in Cordova in 1979 and greatly appreciate that this committee hearing is being conducted in what I will always regard as my Alaska home.

AVEC was established in 1967 as the culmination of an effort of the then-Governor of Alaska to find a way to deliver central station electricity to the small villages that housed Alaska's rural, mostly indigenous population. The task was daunting, given the distances, geography, absence of infrastructure of any kind and extreme climactic conditions of our great state.

Working with the Rural Electrification Administration, now Rural Utilities Service, a unique electric cooperative was established – one that would serve communities whose physical boundaries did not coincide with those of other member villages. This patchwork of electric grids began with three communities that were electrified in late1968. Old Harbor, Nulato and Hooper Bay are an average of 400 air miles from Anchorage, AVEC's base of operations and an average of 470 miles from each other. Our most recent community member, Yakutat, is more than 1,000 miles from Gambell, our western-most community.



AVEC today serves 58 communities in Alaska and does so with 50 separate diesel fueled power plants. Several of our communities have populations of less than 100 while our largest, Bethel, has a population of more than 6,200.

Discounting Bethel, which is more than five times the population of our second largest community, the average village population is 450 – likely less than the occupants of a single apartment building in most cities.

To put the very small scale of AVEC's utility operations into perspective, a village's entire annual electric consumption is the equivalent of half the consumption of a grocery store in Anchorage. All 58 of our communities together represent a population of almost 33,000, about the same as Fairbanks, but the combined electrical usage is less than 1/10th of Fairbanks.

AVEC is, in effect, operating a series of 50 microgrids. These microgrids do not have the luxury of connecting or disconnecting to any other grid – as are virtually all communities and subsections of communities in the Lower-48. Instead we must provide redundancy within the community to allow for planned and unplanned generation maintenance. Extended outages in a community equate to life, health and safety crises almost immediately. During the winter, houses freeze up and human life is at risk. During the short summers, extended loss of refrigeration could mean the loss of an entire season of subsistence food.

AVEC systems typically consist of a stand-alone power plant with three or four generators. Sizing is carefully done so as to operate the most efficient generator to meet the needs of the day and the season. Redundancy is determined based upon having adequate capacity when the largest generator is down for maintenance and another fails unexpectedly. As a result, AVEC owns 85 megawatts of generation to supply an average load of 14 megawatts.

In addition to AVEC's 50 power plants, we maintain diesel tank farms in each community. Because fuel is delivered by barge during the short "open water" season, we must be able to store fuel for an entire year at a minimum. Since weather can delay the arrival of the first barge, we will generally ensure that we have up to 14 months of fuel on hand by the end of the delivery season.

In this day of the drive to distance ourselves from fossil fuels, rural Alaska's dependence on diesel is surprising to an outside observer. Alaska is one of the nation's leading energy states with vast reserves of natural gas. It would seem self-evident that Alaskans' energy needs would be met with inexpensive, low-emission sources such as that natural gas. That is not possible however, because Alaska lacks the basic infrastructure that is taken for granted in other states.

Alaska has few roads, railways, adequate port and dock facilities, paved runways, transmission grids, communication grids and other elements deemed necessary for modern American society. As a result, we have had to develop micro-systems to meet the needs of the people who have been resident in these areas for many hundreds of years. These micro-systems come at very high cost per capita.

AVEC's investment in utility plant to serve our villages is more than $17,000 per service or meter. That is 4-5 times the investment typical in the Lower-48 and reflects the very large redundancy built into our generation system as well as the cost of the fuel storage systems that go with it.

Despite these staggering costs, AVEC has nonetheless been a leader in deploying wind generation in communities with a robust wind regime. We typically install wind turbines that, at peak output, exceed the connected electrical load at the time. We install diversion systems that deflect excess wind generation to passive loads such as water boilers in water treatment plants and other public buildings and reduce the use of diesel fuel in those facilities.

AVEC is unique among American cooperatives for having built and owning two tug and barge sets that deliver 90% of our villages' generation fuel needs.

AVEC has been deploying wind generation since 2003 and owns and operates the largest fleet of wind turbines in Alaska – 34 machines are located in 11 communities and serve another four through modest transmission connections. We are able to achieve 25%+ of our generation from wind in communities with optimal wind regimes. In 2016, more than 4% of the electricity we sold came from wind. In 2018 we will be installing additional wind turbines to increase our wind capacity by more than 50%.We also have a modest solar portfolio. We have developed innovative dispatch systems to maximize the value of intermittent wind generation.

We are committed to reducing our dependence on diesel fuel, which can only be achieved by improving efficiencies and by installing alternative sources of generation. In the last decade, connecting communities has been a priority and we have shut down power plants in five communities, thereby reducing emissions in those communities and improving the efficiency of the generators that serve them. Larger generators get better efficiencies and both interconnected communities benefit from an interconnection.

15 years ago, AVEC was appointed an energy partner of the recently established Denali Commission. The Commission was tasked with the mission of developing sustainable basic infrastructure in rural Alaska – a multi-billion dollar challenge. Energy infrastructure, the basic underpinning of modern society, was the overwhelming need. AVEC developed and pursued the "amalgamated" village approach – addressing all bulk fuel storage and generation needs in a community at the same time to take advantage of construction efficiencies from a single mobilization. As funding allows, power plants are upgraded with sophisticated control systems with intelligent dispatch

that are wind-ready. Smart meters are deployed through the entire AVEC system and virtual SCADA (Supervisory Control and Data Acquisition) systems are being developed.

AVEC has worked with engine vendors to develop machines particularly suited to Alaska's environment. We achieve higher efficiencies with smaller engines as a result. We are replacing conventional public lighting with LED lighting and have converted more than half our communities to LED.

15 of our communities are now served by wind hybrid microgrids. There will be 19 by 2019. We have displaced as much as 40% of diesel fuel in some of our most productive communities with highly innovative dispatch techniques. And we believe we can improve that by 10-15% with hybrid storage such as the Grid Bridge system that we have visualized and are pursuing.

We are working with innovators on emerging technologies – seeking answers to harnessing the forces of nature in wind, water and the earth. We hope to become a demonstration classroom for micro-nuclear generation, variable speed generators and other technologies that are on the edge of commercialization.

We believe Alaska can become a world-class leader in energy optimization by building a hybrid transmission system to replace liquid fuels with electricity generated by clean, super-efficient natural gas supplemented with wind and other renewables harnessed across Alaska. We can attract clean industries that appreciate our pristine landscapes and our inexpensive energy. We can nourish our people and our land through the wise and efficient use of our abundant natural resources.

It is time for a renewed, holistic approach to meeting the basic infrastructure needs of rural Alaska. The US chairmanship of the Arctic Council brought many leaders to Alaska and showed them our state through the eyes of our people. This is where the impacts of climate change are being most sharply felt. This is where economic and living conditions most closely resemble those of developing countries. This is where the vast resources of the Arctic Ocean nurture the land and the people and whose shores will witness the evolution of new transportation, tourism and mineral extraction activities.

I ask that as you consider a comprehensive energy bill, you also include revisions to USDOE's loan program that is currently geared toward "innovative non-commercial" technologies. It should be looking instead at deploying innovative commercially viable technologies, such as what we are trying to do on a small scale.

The federal government has passed legislation to help with the high costs of developing hybrid microgrids like AVEC's. In the 2007 Energy Independence and Security Act, Congress approved the creation of two matching programs to provide grants for up to 50% of the cost of installing proven renewable energy systems in high-cost regions. Unfortunately those grant programs have never been implemented by the Department

of Energy nor actually been funded by the executive and legislative branches. Providing funding for these programs, plus for additional transmission aid, also currently available through RUS, would dramatically improve the likelihood that islanded grids could afford to install renewable energy systems and not only reduce power costs over time, but also reduce the consumption of fossil fuels with their associated emissions.

We need the state and the federal government to work together to help Alaska take its place in leading the Arctic and the world. We need to renew support for the Denali Commission and the Rural Utilities Service, two of many agencies that play a pivotal role in rural infrastructure. We need you to partner with us on solutions for the future. We are the experts. We live every day striving to improve the lives of our remote Alaskan members. We know what can work and what cannot. All too often, we are told what it is that we need, by people who have never lived in rural Alaska, who have never actually operated a remote microgrid to understand the real issues and challenges we wrestle with and solve daily.

We should be expanding our vision of micro-grids to include sustainable clusters of communities that are not connected to a grid but that collectively can be served by robust technologies that represent reliable, affordable, clean abundant energy.

Thank you for the opportunity to testify.

The CHAIRMAN. Great, Meera, we really appreciate that.
Okay, Geoff, bring it home and explain how beer fits into energy.
[Laughter.]
Geoff Larson.
Ms. KOHLER. And why doesn't he have a beer for each one of us? That's what——
[Laughter.]
The CHAIRMAN. Meera, it's not noon.
[Laughter.]
Ms. KOHLER. It is somewhere.
[Laughter.]

STATEMENT OF GEOFF LARSON, CO-FOUNDER AND PRESIDENT, ALASKAN BREWING COMPANY

Mr. LARSON. Thank you, Senator Murkowski, Ranking Member Senator Cantwell. I am intimidated by this panel because——
The CHAIRMAN. So are we.
[Laughter.]
Mr. LARSON. ——because they represent communities and they represent a broader, out-of-self type of responsibility. Interestingly enough, beer has been one of the oldest industries in the world. There are hieroglyphs on the walls of the Egyptian tombs that describe the manufacturing process of making beer. And so, when we started the brewery 31 years ago, I would have to say I felt fairly humbled being in an industry that had such rich history. But over the course of that period, I have become acutely aware that the beer we make is dominated by where we make it, and there are attributes of what we do that are influenced by our environment.
One of them is that we live in a tough spot. We have to do things differently because other people in other areas have industry norms. Oh, it's always done this way. Well, what we've discovered is that our attitude is a little bit different because we have to do things differently because it's not always done this way. Now, I'll give you a couple of examples. When we started I don't think we really thought of ourselves as being grossly innovative but the place creates the person.
One of the things that we do now, we call it Beer-Powered Beer. We take a waste stream which is our spent grain. When you make beer, you take grain, you steep it in hot water, and you extract a lot of the good things that become the end product. But the residual, the waste-spent grain, is something that others can easily deal with in areas where they're close to agricultural users, cattle feed and the like. But there are other facilities that have to dispose of the grain in landfills because they're not close to the agricultural communities.
For us, we knew that we didn't have much agriculture in Juneau, so we very quickly realized we had to do things differently. So we started drying our spent grain. We used a portion of it for fuel, but grain is a very difficult thing to burn. What we ended up doing is developing a process, which we just received a patent for, in regards to using spent grain as a sole fuel source for steam generation.
Heineken Brewing Company tried to do this in Namibia, Africa, because they had a similar situation there. There wasn't an agri-

cultural user for their spent grain. It ends up that they had to abandon the project and what they do is now use a combination of traditional fuels with the spent grain.

Newcastle, in Manchester, England, also did the same thing. They were in a municipal environment that they had to dispose of the spent grain. It was very difficult. They spent $25 million trying to develop a process using spent grain as fuel. They abandoned the project.

We're the only brewery in the world that is using this waste stream as a fuel source for a steam boiler as the primary fuel. We're targeting about 60 percent of our fossil fuel replacement with spent grain.

The Columbian exchange price from spent grain is about $180 a ton, last I saw. At $2 a gallon of diesel, the value of that spent grain to us is $350 a ton. The value is, kind of, an indicator of what that means for breweries. The application of this technology actually is much more broad than just beer.

Thirty-one years ago, I'm just making beer, but creatively I think we're going to be able to change the world. And I think the demonstrated examples that are being talked about here are just that same thing.

The pioneers of yesteryear had challenges and they made it work whether it be the railroad here in Cordova, the history of this town or the White Pass Railroad, but it's giving me goose bumps when I think about what we can transcend here from our locale.

Now obviously, Washington State has a number of innovators and their impact on the world is obvious. But I also think that what we have may be for this portion of population but a disproportionate geographic challenge. We think differently. This state thinks differently, and that application can be international in its impact.

Carbon dioxide is another example that we innovated with. Carbon dioxide is a gas that we use to press our tanks. We use it for blanketing, protecting the beer for its integrity. The most common source of carbon dioxide is fossil fuels.

Low and behold when we're fermenting beer, a whole bunch of carbon dioxide comes off in its fermentation. So, in 1998 we started capturing all our CO2. In 1998, we were able to recover 800,000 pounds of CO2 from our fermentation. The fermentation gas is from photosynthesis. It's a renewable resource, whereas most all of the CO2 used by breweries is fossil-based. We replaced it.

The steam generation that we're using right now for our plant, partially from our spent grain, also has to be down-stepped in pressure. It's enough to get to the pressure reduction process—we're using a stream pro-gen plant—so that we're reducing the pressure by, at the same time, generating electricity.

This is not in place, it's just in the engineering phase at this moment. We have a zero-power strip in our plant so that we basically have the same phase coming in as going out. And it just gives me goose bumps to be able to be talking about things that are a little bit behind the scenes because we're just making beer, you know, we're not saving lives. These people are saving lives. We're just making beer.

[Laughter.]

I really appreciate the opportunity to be here and be before this guest panel, but I also think that we have an opportunity as individuals and individual companies to make an effect that can be more broadly applied and the type of platforms that we create are due to necessity.

So while there may be accolades, I have to say that necessity is the mother of invention. In that light, the opportunities that we are given here within the state, the opportunities that we see every day and enjoy are one of the reasons why we're here and we make it work.

Thank you.

[The prepared statement of Mr. Larson follows:]

Geoff Larson
Co-Founder, President
Alaskan Brewing Company

Innovation in Action – Microgrids and Hybrid Energy Systems
Senate Subcommittee on Energy and Natural Resources
Saturday, June 10, 2017

At Alaskan Brewing Company, we brew the way we brew because of where we brew. That very simple concept goes to the core of every beer we produce, and to the innovative steps we have had to take to grow and thrive as a company. Living on the Last Frontier has always forced pioneers to be innovative. In the past and today, we look at things differently when faced with the challenges of conducting business in Alaska. Because many processes have not ever been done up here, we do not default to "it's always been done this way". In our case, it has made us look at ways of turning what would otherwise be a waste product, into a source of efficiency and energy.

I'd like to mention just three of the steps we have taken because our location made us think in a novel and inventive way about how we could be more energy efficient.

The first is our process of Beer Powered Beer – where we are able to use a waste product to create the steam that helps runs our brewing system. Beer is created by mixing grain with hot water to extract the liquid that eventually becomes beer. The residual grain that is left over from this process is called spent grain and it is the consistency of wet oatmeal. Many breweries in the US are near a cattle farm or other agriculture producer that will buy the spent grain for feed and we are aware of other brewers who dispose of spent grain in their local municipal land fill. But we had a problem – there are no cows in Juneau and landfilling our waste was just not in our minds a reasonable option. So we barged our spent grain to a Washington State farmer that bought it from us. That required us to dry our grain, because wet grain spoils in a few days. By becoming the only brewery in America that dries all of its spent grain, we had a solution for a while, but we were relying heavily on that farmer.

Which brings us to our second innovation. In 2008 we installed a new piece of equipment called a Mash Filter Press that allows us to grind up our grain very fine, so we get a 5% higher yield from our grain, and we also use much less water every year. This reduced the impact and energy cost to our city water and wastewater utilities, while improving our company's financials by reducing our energy consumption, it reduced the amount of grain we needed to brew the same amount of beer and it improved our efficiency. We were the first craft brewery to use this novel technology while continuing to successfully produce internationally recognized award winning beer, and now dozens of other craft breweries have followed suit across the United States due to our pioneering this new approach to brewing craft beer. When we dried that very fine spent grain, we noticed it looked like sawdust. We had used spent grain as a small portion of our fuel to dry our grain, but always in combination with fuel oil. With this new finer grind we renewed our efforts to more fully utilize this as a primary fuel instead of shipping it south. It took 5 years, but in 2013 we were able to begin operating our spent grain boiler – in which we use the dried spent grain as 100 percent of the fuel in the furnace that produces the steam that helps run our operations. Our objective is to replace 60% of our fuel consumption using this new fuel source, and there's every indication that we are going to achieve that and I am expecting to exceed it. Using what would otherwise be a waste product and producing steam that runs our brewing system is what we call Beer Powered Beer, and we just received a US patent on this one-of-a-kind process. Other brewers much larger than Alaskan have tried to accomplish this throughout the world and have failed, not to lessen our achievement but this innovation came about because it was necessary due to our location.

Geoff Larson
Co-Founder, President
Alaskan Brewing Company

Those two innovations – our Mash Filter Press and Spent Grain Boiler was built on earlier work that paved our way toward seeing that innovative approaches often pay unanticipated dividends. One of our first large-scale technical innovations had to do with Carbon Dioxide (CO2). CO2 is used in various stages of the brewing process – including bottling, tank cleaning, pressurizing tanks and carbonating beer. The source of the vast majority of the commercially available CO2 is from fossil fuels. So breweries pay to have liquid CO2 delivered to their facilities – typically by big tanker trucks delivering to their plant's holding tanks. We did that for a while too – but our location made us innovate because we had to barge our CO2 in, we had a single supplier, with little option for us to control the quality of this raw material supply. This was expensive and created quality concerns with the supply of the CO2 we received. The irony of this situation is that yeast produces CO2 when it ferments beer – a lot of CO2. So much so that we were off-gassing 800,000 pounds of perfectly good CO2 into the atmosphere in 1998, and as good stewards of our state that didn't feel very responsible and we were paying high prices to ship CO2 "North to Alaska". So we took the step of being the first craft brewery in the world to install a system that recovered all of the CO2 we needed for our operations from fermentation, clean it, compress it, condense it, store it, and then use it for all our CO2 needs. Since 1998 we have had a closed loop on CO2, and do not buy tankers of liquid carbon dioxide. The carbon dioxide we gather is from grain that came from the atmosphere, not from fossil fuels we use our local electricity to compress and process this renewable source of CO2. We were the first to use this renewable technology decades before any other craft brewery and now others are following our lead because we were able to pave the way by pushing the normal boundaries of traditional plant operations and pioneering our own way.

Sometimes it is painful to not be able to fall back on how things have always been done. In the freshness of looking at new approaches, we have had to make our own tradition. Those new approaches can have additional benefits. For instance, we are now in the engineering phase of adding an electrical generator to be coupled to the steam generated by our Beer Powered Beer process, turning waste into electricity, which we will use internally.

We are only the most recent in a long line of pioneers in Alaska that worked the way they worked because of where they worked. In Juneau in 1917, the miners of Juneau installed the first high-alpine lake tap, a project that still gives energy to Juneau today. That created the technology that supplies Juneau with one of the cleanest sources of constant and renewable electrical power in the world. That's Alaskan innovation, and it happens because when people are pushed to achieve under difficult circumstances, they invent new ways of solving problems. And sometimes those solutions can help change the world.

The CHAIRMAN. Great story, really a great story. I think it is important to add that you are not just some small, local brewer. You have the biggest distribution in the state and are distributing around the country now. So, a remarkable level of ingenuity that has allowed for an expansion to your business that is really quite incredible. Thank you for sharing that.

You know, it does make me wonder as I listened to the panel here and the conversation coming back to how Alaskans are pioneering in so many different ways and different spaces. I don't know whether it is because we have longer, darker winters and we just have more time to think.

[Laughter.]

I think about the sleep of folks out here and those that spent a lot of time in a wheelhouse just, kind of thinking, maybe we have time, more time here to just think about solutions to the daily problems that we have.

But, let me get to questions, not just musing because you all have provoked such great thought here with all that you have brought forward. I challenge any one of you on the panel.

Mayor, you spoke about AquaHarmonics and the great innovation there that the wave generator, and the recognition, that those local folks have achieved.

And the discussion also that you have raised, Meera, and it was great to be with you at that panel a couple weeks ago about micronuclear reactors and advanced storage issues.

Just, kind of, projecting out, where do you all see this next generation of technologies going, that you think are particularly promising, either in the near-term or the medium-term, for solving some of the challenges that we are currently faced with when it comes to microgrid and hybrid energy solutions? And when you think about our coastline, when you think about the marine hydrokinetic potential that we have there, what are you looking at now as that next great opportunity? Again, keeping in mind that it might not take over the world, but it could transform a community here, what are you working on that's exciting that you can share?

Clay?

Mr. KOPLIN. I'll answer in two little pieces and I'll jump, kind of, right to the end game of smart grids.

So I envision a future where someone has a washer or dryer set, for instance. The washer can hold a full year's supply of soap and fabric softener and everything. Once I throw the clothes in I don't care when it runs, as long as it's not in the next 24 hours.

As I open my freezer and close it and take salmon in and out of it and everything, it can learn my habits with very inexpensive robot sensor technology. It's evolved so rapidly. It can learn my habits. And if it's talking to our electric system and knows when renewable energy is available, it can decide when it wants/needs to cycle.

And if it's talking to the system that's, you know, if our grid is also talking to all the other freezers in the system, it can say, let's run these freezers, and then these, and then these, in progression instead of all at once and actually smartly manage people's appliances and uses in a fully integrated way that can almost, kind of,

create demand from the user side. So that's a lot of where the technology can go similar to electric vehicles.

Right now, we're working with Schweitzer again, and the U.S. Air Force has a grid-to-vehicle program that they're just, kind of, reaching the end of. And as I think you mentioned, Senator Cantwell, the Department of Defense also has frontier installations and what not.

But we have the Coast Guard here and as you know they're considering two fast class cutters in Cordova, but imagine an environment where they can not only provide their services here but also engage with the Department of Defense, through the Department of Defense in some of these new technologies where these excess electric vehicles from the Air Force, with their smart grid technology, our smart system can charge those one day when we have some excess power, and then discharge them back onto our grid.

I see a future smart grid where we can use automation and sensor technology and this world class technology that Schweitzer Engineering labs, one of our partners in Washington, is really involved with.

A second little piece would be, oh, I lost my train of thought. I was thinking about AquaHarmonics. But oh, one little piece, about 15 years ago I wrote a little white paper with Institute of the North on cryodams. We have such tremendous amounts of steel and concrete required to build our hydroelectric plants, yet we have glaciers that naturally dam some of our rivers and develop huge repositories of water. So why not do that intentionally? Why not use our local glacial silt and wood pulp?

One hundred years ago, during World War I, the British—or World War II—the British built a frozen aircraft carrier in Canada. It took it three years to thaw out when it was done.

So, particularly in Greenland, where they have some excess hydro in places, they can use that over transmission lines to freeze materials and use that as our dams of the future, maybe.

And now that we have advanced micro technology of carbon fibers to reinforce them, sensor technology could literally blend in with the frozen material that can communicate the stressors and strengths. We have a next layer of technology now that can maybe make something like that possible.

We just find that we need to find a way to test it and through FERC on federal land would be tough, but that's why partners like Greenland, again, they have the necessity. They have ice, rock and water and very little else. I mean, the extra technology we can share with them.

The CHAIRMAN. One of the things that we saw yesterday that was very interesting at McKinstry was basically just computer panels. What we were looking at was all of the schools within a particular school district and they could tell where you were losing energy, where there was inefficiency.

You send a note off and somebody does something and the next thing you know everything is handled. But, you know, when you think about our schools and the amount of money that we spend just to keep our schools heated and warm, so much so that it comes out of the academic side of the budget equation. We've got Senator Stevens here with us and he knows the impact to our schools when

our energy costs are high, which is from the smart technologies that are out there. So, we could be doing so much more.

Others? I'm over my time, but go ahead, Meera or Gwen or Dr. Ellis? Go ahead.

Ms. KOHLER. Well, you know, we have demonstrated very high penetration renewables in our communities, but we can go a lot higher. We now have 15 communities served with wind with eleven wind farms.

We've got two more large turbines going in and one of them is going to be a pretty unique installation because it's a 900-kilowatt machine in the community of St. Mary's which is a very small community.

We do have the ability and I'm going to be connecting them with another village which is still going to be at about 150 percent of peak capacity with that wind turbine. And so, what we're working on with the grid bridge concept, I think, is going to get us a long way.

But one of the technologies that, I think, is not being paid enough attention to is the potential to use hydrogen from, you know, water. Everybody has got water. Every village has water.

Can we come up with a relatively low-cost, hydrolysis program to create hydrogen to super charge the diesel fuel that we are using? I mean, it's all about efficiencies. That's the reason we have wind is to get the most kilowatt-hours per gallon of diesel fuel.

If we can use the surplus wind to create hydrogen to get even more efficiency out of that diesel that, I think, is a relatively seamless technology. Right now, it's not commercial, but maybe that's something that we could focus on as to how we can put some of that excess renewable energy to good use.

And also, the issue of connection. Alaska, as I said, is an energy-starved state and what Gwen and I had and a few others have partnered on, Rob also, is the concept of HVDC, a large HVDC grid across the State of Alaska which would allow us to put very large amounts of renewables in with very inexpensive natural gas from the North Slope and displace millions of millions of gallons of diesel across the state to feed our energy-starved industry.

As I said, Alaska sells six billion kilowatt-hours a year which is half, less than half, of what Sacramento sells. That's just a crying shame.

Our industry is starved. We can't attract good industry, like Cira Farms, the high-tech technologies up to Alaska because we don't have affordable energy. There is no substitute for affordable energy.

So I think that there are opportunities for partnership and evolution that are second to none.

Ms. HOLDMANN. I'll just, kind of, follow up on what Meera is saying.

I think right now, what Meera and other utility managers are doing in Alaska is really pretty incredible. I just want to highlight that one more time.

You said 40 percent displacement of diesel fuel in some of your communities but at an instantaneous penetration level she's getting to 100 percent on a relatively regular basis. I don't know how many utility managers in other parts of the country would feel

comfortable with 100 percent penetration of wind energy on their grid. That's just not something that's done anywhere else, I don't think, in the United States on a regular basis. And so, right now, I think what we're really focused on is improving process efficiencies in the short-term.

How can we do better along the lines of what we're already doing? That could be, like for Clay, looking at how do you factor in frequency regulation using your hydro so that you can maximize your hydro potential and use other ways of actually getting that frequency regulation where right now you're losing 10 or 20 percent of your potential production because of that? Or for Meera with this grid bridge system, this is going to give her the chance to eke out a little bit more efficiency.

A lot of the utilities in Alaska are using this demand response, basically having thermal loads and other loads in specific locations like, for example, in Kotzebue they have an electric boiler in the hospital there that is turned on and off based on how much wind energy is being produced at any one time. And the utility controls that.

And so, that's a way that we're really able to manage the energy production as a whole, not just looking at electric power, but also these heating loads. And there's days where they don't need to run their other, their alternative diesel-fired boiler at all. They're just running on electric power.

So, looking at distributed controls, we are working with ABB on that. They've been a big player up here in Alaska. I know you heard from Siemens the other day in their testimony to you.

You know, getting these companies up here to partner with Alaskans is really important, and you can help advocate for that because we can work with them to harden their technologies. I think that's something in the short-term that we're thinking is important.

Electric vehicles is a piece of that and then also this built environment question, you know, we've been doing a lot. The Cold Climate Housing Research Center is not represented here today but they have a Northern Shelters program, really making sure that our building systems are appropriate for the environment is important.

Long-term, I agree with you, Meera. Transmission, trying to figure out ways to reduce the cost of transmission using like multinodal HPVC is something we're quite interested in up here because that would be the strategy for building out a grid in larger parts of the state.

Energy storage continues to be the Holy Grail. I don't think that we have the optimal solution for that yet. So, that's something that I'd like to see the Federal Government continue to invest in.

Hydrokinetics, ocean, wave, river energy. That's something that's really important up here in Alaska because if we can find effective and cost-effective ways to take advantage of our water resources, it would be very beneficial. Almost every community in Alaska is based on some sort of body of water.

And then nuclear, you mentioned the small, mini nuclear solutions and the small nuclear battery that you can bring in to these remote places. I really think that is something that we need to be

looking at. I'm not always a proponent of Alaska needing to be a first adapter of these kinds of technologies, but long-term if we had really safe, reliable, small, mini-nuclear reactors, that would be an excellent solution for many remote places in the state too.

The CHAIRMAN. Senator Cantwell.

I know we will have an opportunity to continue this kind of open dialogue.

Senator CANTWELL. Well, thank you, Madam Chair.

This is really fascinating. I have so many things that I want to ask, so I will try to come up with a couple of broad things for all of you.

I think for Gwen and Dr. Ellis, on the topic of technology demonstration. The Pacific Northwest Lab did a demonstration out on the Olympic Peninsula on dryer usage and other appliances and showed that you would get double-digit savings.

But it strikes me that our national lab is going out to one geographic region of our state trying to prove a theory. But to your point, Gwen, why wouldn't microgrids just be a go-to technology for people every day of the week? If you were either the national interest or a private interest, the microgrid is the best beta test you could possibly ever have. I mean, you could probably get it done in a week and you could find out what is happening.

I know we have in our bill a provision to promote some demonstration projects on microgrids, but should we be even more aggressive given how much information that we could learn by doing these small-scale deployments? We would just be getting so much information back so quickly.

Ms. HOLDMANN. Senator Cantwell, I would just like to make the point that I really appreciate you recognizing that we have this unique opportunity to be testing and demonstrating things in Alaska. We actually don't like to think of it as being demonstration and pilot projects. We're a little bit, we're beyond that.

Senator CANTWELL. Right.

Ms. HOLDMANN. We just want to make the step work, not just over some short period of time where there's some funding, but we are looking down through for the long haul and making these things work and our utility managers are really very, very willing to be a strong partner in that.

I think one thing that both of you are, I believe, aware of is that at the federal level our Alaskan grids don't count as microgrids, according to the federal definition by Department of Energy. And that's hindered us really significantly in terms of being part of these longer-term testing kinds of scenarios.

A microgrid at the federal level for the Department of Energy is a small grid that can island and isolate itself, but it needs to be able to connect to a larger grid or else it's considered separate, you know, an islanded grid. And so, there's money put aside for looking at specific situations around islanded grids. But I really think that we need to be thinking of this as just a microgrid and the fact that we're not connecting to a larger grid is really irrelevant because the difficult part is about the islanding part.

And so, when the Department of Energy, you know, calls us out as not counting, I think it really hinders our ability to be part of that national solution.

Senator CANTWELL. Dr. Ellis, should we be doing more demonstrations on microgrids?

Dr. ELLIS. In my opinion, absolutely. There are many, as I said in my opening remarks, interesting technical questions that haven't been answered in detail.

Just to give you a couple of examples. Some of the microgrid demonstrations that we do work hand-in-hand with stakeholders and those have to do with high security applications, for example, where we don't, not only want reliable electricity from the point of view of electrons, you know, being delivered to the load, we also want to make sure that those energy systems are cyber-secure.

And so, sometimes we don't think about these things, but for some applications it's absolutely paramount. So we're trying to push the limits on what it means to have secure energy supply that is able to withstand physical and cyber threats in different applications. So, with definitely some more of that.

I also want to point out that, you know, this issue of trying to get to 100 percent renewables in practice is very hard. What has been talked about today in some communities—kind of, get there by putting in 10, 15, you know, 20, 25 percent. By the time you get to the kind of penetration levels that we were talking about in some places here in Alaska, things become rather difficult. It's not a lot of fun to think that you're relying 100 percent on inverters and batteries and things that, you know, you hope nothing bad happens.

So we're looking at cases within these microgrids that might be a little bit extreme so that we can in the future guarantee that these systems really are robust. For example, when you're running on 100 percent solar or wind some of the things that the engineers worry about is what happens when there is a fault on a line. With a typical power system that has rotating machines, like a micro hydroelectric, the system is able to ride through that fairly well. But the dynamics, when you look at that in detail, are very different when you have 100 percent penetration of renewables.

So it is really those cases that we are trying to iron out from a National Laboratory perspective to make sure that new systems are bullet proof, so to say, at 100 percent penetration. And some states are going in that direction. You've seen, for example, the story of Hawaii, that's where they're going. There are other countries, including places like Ireland, that have similar goals. They are at a high penetration level, but as they go there they find somebody's technical problems that are challenging down in the details. So, we think, we believe that more demonstrations that showcase how to solve those problems, those age problems, are extremely valuable for the industry.

Senator CANTWELL. I think that is so important and should not be lost about the advent of microgrids that they offer so much from a test bed perspective, but having been involved in the early days of internet media software, I can just tell you that you sit around and talk about, "how is this going to play out" and "how is that going to play out", and then all of a sudden you can just make it live and instantaneously get feedback from it, from thousands of people was a great asset, something that we were not able to do before.

So, to me, the microgrid, whether you are talking about security or you are talking about the technical problems of integration of renewables, we should be making sure there are adequate resources there to allow the microgrids to give us more information. I'm saying just broadly—technology takes up so much time.

Dr. ELLIS. It does.

Senator CANTWELL. And you can get us instantaneous feedback and some real-time information.

I also think, as we start this era, which I guarantee you is going to end up being one of the most tumultuous eras of what a utility is today, okay? There is going to be a transformation of how energy is generated and put on the grid and delivered back to the home.

I mean, I am pretty sure in 20 years, 25 years, we are all going to be in the energy business. That is, our home is going to be in the energy business, and it is going to be generating something and it is going to be putting it back onto the grid.

Right now in Washington, we have very high electric vehicle deployment. That is because of our cheap electricity rate and the interest of the public. So we will end up trying to think of electric vehicles as battery storage in our communities and whether it is smart to charge our car at night and then the next day, charge it back onto the grid at the cheapest kilowatt rate.

Those kinds of things are going to transform, in the next couple decades, how utilities are perceived and how they work, and you are the tip of the spear of that in reality. You are the tip of the spear because you are doing that right now. The microgrids are doing that right now.

Microgrids are helping us think about these relationships between what is a utility and what is the consumer and what are they developing and what are they putting onto the grid and how are you going to get it. So Alaska could play a very valuable role for our country that way.

So I appreciate that.

And Mr. Larson, I don't know that you are claiming the title renewable beer, but you are getting pretty close.

[Laughter.]

Mr. LARSON. Well, I actually have some oblique comments in regards to that. You know, Juneau's an amazing community. Alaska is an amazing state. In 1916, February 14th, the first lake tap in North America was put online and that was a high alpine lake, tapping the anaerobic area of the lake where basically no adverse effects were being implemented in the environment, basically because of necessity those pioneers that wanted power for the mines. Well, that lake tap and its creek is still supplying, I think, about 10 percent of Juneau's power, 101 years later. Juneau is 99.9 percent hydro; however, hydro is blanketed as a non-renewable resource because of the impacts having to do with dams and the like in other areas.

This truly is a green power source, and I think we should start thinking about other types of issues. That's something that really needs to be addressed. I think the fact that we are 100 percent green electricity, the renewable resource needs to be recognized, but it's not on a federal level.

Senator CANTWELL. Well, I can tell you that BMW builds the car or parts of a car in our state, the i3, because they market that car as a totally renewable car. Every aspect of that car can be renewed in that the electricity that it uses comes from hydro, so they call it a renewable car.

We are going to see more of this as consumer interest shifts that way, but you are saying that you had a 60 percent fuel——

Mr. LARSON. Reduction on——

Senator CANTWELL. Reduction.

Mr. LARSON. For steam generation.

So what we end up doing, we use electricity for much of our refrigeration, but we also, in the process of making beer, you're boiling the precursor to essentially remove all the good stuff from the hops that we get from Yakima.

[Laughter.]

But in that we need fossil fuel, so that's where we're replacing 60 percent of our fossil fuel use.

But the interesting thing that Mayor Koplin brought up is one of our electrical uses is the refrigeration. Now our refrigeration needs aren't on a demand issue. We can delay certain types of refrigeration initiations based upon the peak loads of the utilities. I think that's the other point I was going to maybe mention.

And again, these are very sophisticated, regulatorily controlled processes, but there are ways for industry to partner with the local utility. But because of bureaucratic time and effort——

[Laughter.]

There's just no way. I mean, it's understandably for good reasons, but I look at our utility's hydro. I mean, they have interruptible power sources. And historically, the way they used to do it is they would partner with industry and allow industry to bear the burden of the exposure in risk and cost because they were on diesel.

For example, our Kensington mine, which is a very large mine outside of Juneau, is on interruptible power. So, during those periods of time when the hydro reservoir is deemed depleted to the point where maybe they will have to sit there and go to a diesel backup, they have certain interruptible users. Green Street mine is one of them. So they will go offline. They have to go on diesel.

Now, that's an on/off situation. And you know, quite frankly, a very large user, it makes sense to go through the bureaucratic labyrinth to be able to get that done and have it approved by the regulatory agencies.

But in a situation like ours, where there's a peak load and in our community on specific diurnal cycles that are well known by the utility, we could have our refrigeration delayed by two hours, three hours. There isn't that flexibility within that regulatory compliance for us to be able to partner.

So when you're talking about the dryers, guess what? We have a one megawatt service and that peak issue that they face, they fear our spikes.

Right now, we're controlling our refrigeration. We're basically able to sit there and start to reduce our peak demands because of the fact that we have higher sophistication in monitoring our systems. But we're doing it independently. If we partnered with our

utility and could do that economically, we could reduce significantly our impacts on the utility. You gang that up, and we're basically doing exactly what's being proposed here.

Senator CANTWELL. So flexibility, a little flexibility, as well.

Mr. LARSON. Yeah.

Senator CANTWELL. We will look at that.

Then do I understand, you have patented some of this technology and it is being deployed across the industry sector now?

Mr. LARSON. Yeah. And the thing is that, it sounds like, no, no, there's no question. It's situational. Certain breweries are within maybe a very large metropolis and they cannot take their spent grain out to the agricultural users. They have a problem.

There are breweries that are landfilling their spent grain. Even though that was an option for us, theoretically it wasn't an option for us, you know, ethically.

I'll tell you what, you know they talk about the cutting edge of technology? I call it the bleeding, fleeting edge of technology because it's extraordinarily painful. It's extraordinarily expensive, but where there's a will, there's a way.

And you know, you just put down and we sit there and sometimes look at life cycle cost again. I remember the first five years of operations if that piece of equipment didn't pay for itself in one year, we weren't going to do it.

And so, then things changed. Now you can get loans for five to seven years, commercial loans. So if it pays for itself in five to seven years, okay, that's a viable approach.

Well, some of this is that the payback circle is much, much, much longer. But situationally, it could be a non-starter for a brewery in some remote location or some downtown municipality, like in Manchester, England.

But it's not just marine technology. There's a lot of types of materials that are very difficult to burn. Micea, from a pharmaceutical industry. It's a biohazard and they have a very difficult time. It has a very strong problem in its combustion. They tried to incinerate it and they have to use a lot of fossil fuels to do it. Well, our technology is applicable to it. And that's just one of dozens of different types of things.

But I go back to, you know, I'm inspired by the history of our pioneers and I look back at, again, in 1916. What in the world were they thinking? They sat there and tunneled under this high alpine lake and tapped it, and then Spanish Champion in the '60s and then Lake Dorothy. Juneau is hydro.

They've also taken that innovation and applied it to interruptible power users. They do that on a community basis for those people who have electrical heat in their homes. They have programs where they can interrupt their heat use.

I just think it would be great to have even more barley base so that we can all work together as a community to reduce our needs. This is one way of reducing our needs, and it is a cheap, cheap, cheap way.

Senator CANTWELL. Yes, it is. Thank you.

Madam Chair, I have more questions.

The CHAIRMAN. Oh, I know. We have tons of questions, and I am sure that everyone sitting here would love to jump in.

You mentioned a little bit, Geoff, on the investment side. We talk a lot back in Washington, DC, about this "Valley of Death," where you have the innovation that is going on in our national labs, in our universities, in entities like ACEP here and then you have the problem of getting to commercialization and actually seeing that translate into viable activity and action.

I know that there are probably a few people here in the audience that are actually interested in the investment end of things.

As a state, right now, our Alaska Renewable Energy Fund, as I believe, has no money in it. We have had opportunities for the state and various programs to help facilitate some of the investment.

At the federal level there are, obviously, grant opportunities to help build things out, but so much of what we see that is lost between the good idea and getting into play so that there is benefit shared, is kind of in this valley where it is just not enough to allow for the public-private partnership to move forward so that you have this level of investment.

I appreciate what you said, Meera, that while they need a level of testing, and Alaska can be this great incubator for good ideas, we cannot be a test bed just for the purpose of being a test bed because we need to have these applications street ready, because if they are not you have communities that are in the dark and in the cold.

So how do we do a better job, again, with the partnerships that must take place at a time when the state is facing financial issues? From the federal perspective, we have some real serious budget constraints that will be upon us as we are moving forward in this next budget for 2018. How can we be most helpful at the federal level, then, to help move good ideas from the incubator to commercialization in a manner that is going to be helpful?

Geoff, you speak about the history over 30 years of what you were able to do, you have to have your investors that believe in where we are with this. How are we making it happen in Alaska? What can we be doing better at the federal level to help facilitate that and whether it is specific programs that we should be looking at, give us that information, but help me out here in terms of how we make sure that the good ideas that we talk about now do not get lost in this so-called "Valley of Death?"

Ms. KOHLER. And I'll just touch on it real quickly.

All too often we have federal agencies, like DOE and others, that basically helicopter in and they tell us what wonderful things they're going to do for us and how they're going to transform our world and then they leave——

The CHAIRMAN. They need to be listening to you.

[Laughter.]

Ms. KOHLER. They do. We need to be involved. They need to involve us in coming up with solutions. I think that Sandia's presence here is wonderful. We need the national labs to be major players. I think ONR has just been a fabulously receptive resource.

But we do also have, for example, the NAI Commission and the High Energy Cost Rent Program and others like that, that have fostered innovation and both need to be continued.

The CHAIRMAN. Great.

Ms. HOLDMANN. I'll kind of jump in from where Meera started there.

I think one of the things that I believe that we can look at is how we're using existing federal resources and, kind of, use them a little bit more wisely. Like Meera was saying that a lot of times we have folks from the Federal Government, from labs that are, kind of, helicoptering in, I'll use her words. and providing technical assistance for our communities.

But it's like what Clay was mentioning with NREL when he pointed out that here the Eyak Tribe could demonstrate best practices in some ways. I think enabling Alaskans to really be providing that technical assistance for our communities that are struggling a little bit more makes a lot of sense rather than having federal resources providing that technical assistance.

And then where we really need technical assistance is to the, kind of, higher functioning people that are looking at those next generation kind of things. I would love to have folks from Sandia come and embed with ACEP and work with us and our utilities on specific solutions.

That would be such a wonderful use of federal resources that we can learn from one another, that we're really benefiting from working together on these solutions rather than having labs that are just going into communities and providing technical assistance in ways where they don't understand the complexities of what is happening in Alaska. It winds up being that people, like me and Meera and Clay, wind up playing interference a lot of times with some of the things that are then proposed or suggested.

I think also, earlier involvement is important. And since we're talking specifically about innovation here, what I have really found, I've been really involved in this and thought about it a lot, been involved in it at numerous levels. And we need practitioners involved at an earlier level in the technology development process. I think that's really important.

If you have folks like Meera that understand how things work at the end of the day, working more closely with the companies that are at an early stage of technology development, you're going to have a much better outcome in the end.

We have this laboratory and we test the things at the utility for people. We have a full power fault simulator so we can simulate. We can actually not just simulate, we can do a full test at full power levels to make sure that we can see how the equipment responds.

But why those guys that come in to see these new technologies, they never thought about how to actually integrate their technology into the system. They have not put any thought into that. They just figured that's going to happen at the end of the day, no problem.

But actually, if they thought about it at an earlier point, it would have saved a lot of hiccups along the way. So getting us Alaskans more involved early on in this technology development team, because it's not just one "Valley of Death," it's multiple "Valleys of Death" that, I think, happen. We've got to get practitioners involved at an earlier level to make better decisions as that's going

along and have immediate partners that you can have engaged, as you're, kind of, trying to mature the technology.

The CHAIRMAN. Great.

Ms. KOHLER. And you know, real quickly.

One of the challenges that we run into is federal officials from various different departments coming in and trying to direct interaction with communities where you basically wind up being competition with the utility that's struggling to provide the type of affordable service that they demand. And then you wind up with cost increases a lot. So that needs to be taken a look at. Sorry.

The CHAIRMAN. Great, no, I appreciate that.

Dr. Ellis?

Dr. ELLIS. I just wanted to briefly, I agree, first of all with the group so far on this area.

Coming from a National Laboratory, you know, my perspective is that we could do better in terms of information sharing among the National Laboratories, among the institutions that work in this area. I think that promoting an easier way to share information through some sort of a consortium in this area would be really, really good.

There's also something that we could do, I believe, a little bit better from the standpoint of National Laboratories to make it easier to partner with the private sector with companies that are developing, as you call it, technologies that are in the early stage.

We are there to serve the country, the nation, but the way that the National Laboratories work sometimes make it a little bit difficult, I think, for, particularly, smaller companies to partner with us.

So we could use a little bit of help, you know, maybe reviewing those processes or what are the available options for the national laboratories to really support the kind of partnership like, for example, the MHK of folks that developed some of the imaginative technologies here.

I'd also like to say that we need to think of some of these challenges in the long-term. I don't like this idea of parachuting into communities and saying you're going to save somebody or whatever and then disappear.

Some of these things actually take time, take a concerted effort over time. And I think that thinking about programs that are long-term, stable and that have goals that need to be pursued hand-in-hand with the local stakeholders is something that we could potentially do better, to define those kinds of longer-term efforts.

And we do that, I think, very well for science and technology development, things like oh, I don't know, codings and you know, biofuels and things like that, but when it comes to systems integration, it just seems like a page of that partnership is such that they're volatile, you know, a one year project and then it's gone. And so, I would love to see more of this, sort of, longer-term projects that have us working hand-in-hand.

The CHAIRMAN. Integration is the key.

Geoff? Clay?

Mr. KOPLIN. Go ahead, Geoff.

Mr. LARSON. Okay.

Innovation gets back to the bleeding edge of technology. Innovation is very painful, and small purveyors have different ideas and then can implement them.

I think if there's a way that some of the risk on a financial basis that could be defrayed would be great. I'll give an example that we have. We put in a mash filter press which is, kind of, a unique technology. No craft brewery in the U.S. uses it. And what it is, it's a press that actually uses much less water in the manufacturing of that precursor of beer wort. But the press itself ends up yielding a very dry cake at the end of it. We end up using six percent less malt to get the same amount of beer. And well, the first year we reduced our water usage by two million gallons of water. We're one of the lowest water users per gallon of beer in the United States. In fact, we were cited for best practices for a brewery that uses a resource to reduce your water usage.

But how does this affect energy? Well, our lack of discharge of that five percent of the sugars because of the way we processed, does not go down the drain. That less water does not go to our utility. The power savings, not only internally because we use less water, we have to heat less water up. The power savings of our utility was strategically motivating for us to put this piece of equipment in. We are the first one in the United States to put one in for the craft sector. Now there are over two dozen small breweries that are using the same technology. Sometimes you have to risk it. Well, we risked it for a lot of reasons.

We're in a small community. Our impacts on our utilities are strategically important. Without the water, we ain't making beer and without the wastewater treatment, we're not making beer. So it's a collaborative effort in reality and ethically.

If there's a way to be able to identify that sort of risk in technology, it can be magnified in its result. We proved to others we can make international award winning beers. They didn't fear putting in a mash filter press. And now——

The CHAIRMAN. Clay?

Mr. KOPLIN. You know, Lewis and Clark, before they headed West, were classically trained for almost 10 years in everything biology. They were renaissance men, you know, by choice. They needed to know how all the tools worked.

They were doctors, had the best medical technology, literally. They became experts at just about everything they could. But they took Indian guides with them starting from the East Coast all the way back, and that's how they crossed the "Valley of Death" and the rivers and the mountains and the terrain and the poisons and the unknowns.

That's how they got to their destination. It saved their lives several times having a cultural guide who understood the cultures, even though they weren't maybe directly related to the Indian cultures they crossed all the way West into Washington.

It's amazing to me that some of the most amazing innovators and technologists are right here in our state, four, five, six hundred years ago and back for thousands of years, lived on the Arctic Slope. I mean, think of the resource limitations there to have a sustainable society.

Anyways, we need to get back to the future and figure out whether we can't capture some of those processes and what not. I mean, I know you wanted to have a native represented on the panel today and that got a little tangled up, but they are some of our strongest partners.

But we can be those tour guides for the national labs. They've got that robust technology and all of the best state-of-the-art equipment, but we can bridge that cultural gap and the real need on the ground and I hope things happen.

We're just so used to trying. I laugh at Meera's hydrogen example because I literally took a mason jar filled with water and baking soda and ran an electric loop off the ignition of the car and made a hydrogen generator that we were plumbing into the air intake on our vehicles because we wanted to try it on our trucks first.

We were at it for several months and looked at our mileage and everything. We had a 15 percent gain, until we realized the oxygen sensor was automatically compensating and burning more fuel to try to make up for it.

[Laughter.]

We thought why are we getting 15 percent gain and it turns out we were just driving more carefully in accelerating.

But that's how innovation happens, right? We learned a way to save 15 percent but the hydrogen thing, that's even better.

[Laughter.]

So, and that's what we really want to do, and our investors are our members. It's the Grey's and the fishermen that pay us huge electric bills.

We have to give a return on investment, and that happens by better utilizing the resources we already have, getting more out of our hydro projects. We spend more in hydroelectricity, probably, in some years than we use in diesel fuel. So that's why it's a survival class. It isn't just a laboratory concept.

If we can get together early on in these processes and work with the labs, as Gwen was suggesting, the whole journey gets much more efficient and the destination ends up being a lot more productive.

The CHAIRMAN. Well said. I would say that Alaskans have a Ph.D. in living.

[Laughter.]

And do not ever underestimate what it is that we are able to learn and then to share as we facilitate innovation.

We are going to try to wrap this hearing by noon.

Senator Cantwell, why don't you take the last 10 minutes for your series of questions here?

Senator CANTWELL. Okay.

Well, thank you, Madam Chair, and I again so appreciate the panel.

I wanted to ask Gwen about this cold climate research, kind of tying in a little bit of yesterday and a little bit of today.

Where are we with buildings and building materials and the science and integration and using that to helping us with savings on the grid?

Ms. HOLDMANN. Yes.

Senator CANTWELL. And what else do we need to do to help be supportive from a federal perspective in the research of the Alaska hub?

Ms. HOLDMANN. Right.

Yeah, I think, you know, each region and we all have many different kinds of climate in the United States in different regions, from pretty tropical, hot areas, to very, very cold areas in the Arctic.

And so, I think the issue around really locally appropriate housing that is going to both take advantage of the kinds of energy needs, locally, whether that's cooling or heating, in addition to, sort of, the way that people use their home structures, like the way people in our communities they really use their homes for social purposes. It has an important social, sort of, aspect to it.

So having small rooms and small spaces doesn't always work as appropriate for supporting the culture in our communities. Really coming up with strategies in this northern shelter program that the Cold Climate Housing Research Center has developed is important. It is a nonprofit. That is, a private nonprofit. We work with them really closely because we're more on the grid scale, community scale. They're doing the built environment.

And so, making sure that we're looking at that really holistically and thinking across that entire spectrum, I think, is really important. And these are places where what they're doing is really critical. But, as the state has less resources, those are programs that are really in danger of really losing steam and how can we really try to find more federal partnerships to try to shore up some of these really significant areas of expertise that have been developed?

Our Mayor in Fairbanks where the Cold Climate Housing Research Center and the Alaska Center for Energy and Power are housed, has a net zero home in a very cold climate that's completely off-grid. Not because he wants to be off-grid, but because there is no grid where his house is, where our Mayor's home is.

Fairbanks prefers its hot bed for research and innovation, in a way, that is sort of partnering across the state, but we really need to keep in mind the housing component to it. I think it's really important to be thinking about things like insulation and weatherization.

Senator CANTWELL. Well, one of the reasons the legislation that Senator Murkowski and I have supported is the next step we think is it is really targeting smart buildings. Forty percent of our energy use is in buildings and these facilities, I equated, to the next phase of efficiency given the fuel efficiency in automobiles drove the last chapter over the last 10 to 15 years. This next chapter is about getting that efficiency out of the building side to reduce that 40 percent.

What else do we need to do to help since we are not really a federal partner right now on the hub? What else do we need to do to help look at those solutions that are being deployed here?

Ms. HOLDMANN. I think a lot of things that have been, that you are already paying attention to, I think both of you are doing an excellent job and—on where we need to be going and really, kind of, putting together this framework or this roadmap.

I think the important thing is to, kind of, pull Alaska into these solutions because these things like demand response, all the buzz words that we are talking about at the national level, a lot of these things are already being done. The utilities figured out how to sort this out with customers.

We have such small utilities here. How many utilities, like 140 in Alaska or some crazy number that Meera was quoting the other day. You know, they're very willing to push the envelope and come up with new strategies. So getting Alaska to be part of that is important. We are a microgrid in this state, this is what we're doing here and it's relevant to this national picture. We've done a lot.

Senator CANTWELL. Dr. Ellis, do you have a comment on that?

Dr. ELLIS. Just a quick comment here.

We have been talking today about the issues surrounding energy. For us, at Sandia labs the Arctic also represents a whole lot of other challenges. There is a lot going on in terms of changing climate in the North here where it's affecting communities. It is a question of national security. And in other cases, energy is part of a much larger set of issues that we have to deal with here.

I wanted to point that out because, you know, we have been, Sandia has been working in this area for a very long time in terms of climate modeling, doing measurements, tracking things like ice movements and things like that. And it is an important aspect of what we do. And I think really, in terms of what can be done from a federal standpoint to see some of this opportunities flourish, it is very critical.

I would challenge, I think, all of us to find ways to connect some of these initiatives. I know that the Department of Defense, for example, has a high interest in the region as well. You know, I heard from Gwen and others that they are actually funding some of the work in energy you're doing here in the state.

I think that, perhaps, there are more synergies that we can see or that have come to the surface that we need to explore.

Let me take one second only to, I meant to earlier, make a comment about your question about whether or not in definition of microgrids really covers remote communities. So that's an issue that a DOE program manager has discussed before with his team of laboratories that are working in this space. You know, I think as a laboratory team we're all of the opinion that the definition isn't really meant to exclude remote communities. In fact, some of the projects that are being funded through these microgrid R&D programs are specifically targeting remote communities.

For example, the Island of Skagul, near the Aleutians is one of seven major projects to try to understand what we can do from the standpoint of better controls, you know, better ways of managing microgrids that are isolated with a lot of renewable resources. That's one of those projects.

We're also working on new design methodologies and tools for upgrading microgrids. Both, by the way, AC and DC microgrids. And those are also targeting results. Just wanted to make it clear.

Can we do more? Absolutely. But, you know, we're all in that, sort of a constrained resource sort of a situation.

I'm actually leaving here energized with the opportunities to, not just from a technical standpoint that are here in Alaska, but, you

know, understanding that people here really want to, out of necessity and otherwise, make a difference. I think this is a great place to move things forward.

Senator CANTWELL. Thank you.

I know we are out of time, Madam Chair, but I just wanted to respond to the Mayor.

When Lewis and Clark got out to the mouth of the Columbia River, they got waylaid because of the treacherous nature of the mouth of the river. In fact, there is a plate there commemorating it called "Dismal Nitch" which kind of gives you an idea of how dismal it was.

[Laughter.]

They were without food and without a proper canoe to meet those headwaters, and the local tribe showed up to show them where to get food and how to build a more sturdy canoe.

The reason I am telling this story is because in Clark's journal he writes that nowhere, anywhere in America did he ever see a tribe so influenced by women than he had when he came to the Pacific Northwest.

[Laughter.]

So I think, Senator Murkowski, it is in our DNA that——

[Laughter.]

That this region of the world likes to be represented in the collaborative fashion that women bring to the table.

I thank everybody here for their participation in today's forum. We will take these ideas back and try to work in a collaborative fashion for the very applicable innovation that is here in Alaska.

Thank you for your great contributions.

The CHAIRMAN. Well, Senator Cantwell, I would like to thank you.

I do have to say that as I listened to each of our witnesses this morning, I cannot help but just feel so proud as an Alaskan. I do think that we recognize that we have a great deal to offer, but it is not just talking about it on paper. We are living it. We are doing it. We are making it happen. And we are capturing the attention of the rest of the country and the rest of the world.

And so, for those that have been dogged in their efforts for decades to build a business where you are just making beer, but what you are doing as you are making beer is you are allowing others to believe in some things that many had just said were not possible.

I think we recognize that for Alaska's future going forward we have to continue the level of innovation. We have to develop a level of resilience and almost autonomy, if you will, within our own communities.

But I think that it clearly brings about a level of challenge that stretches the mind and allows us to not only make good things happen within our communities, but then how we share that with the rest of the country, how we share it with the world.

I firmly believe that so much of what we see happens here in the energy space can be replicated around the globe because we are allowing that innovation to be brought down to a smaller scale that there is room to move up and we are demonstrating it here on the

ground with great minds and great people leading to great innovation.

It is not very often that during a Committee hearing I actually present a gift but you are a guest in our community. I know the Mayor has a jar of salmon there that I will allow him to present. I wanted to make sure that you didn't leave town without a gift from Copper River Fleece.

[Laughter.]

When you come to Cordova you must leave adorned with some aspect of something from Copper River Fleece.

So, from those of us here, we thank you for your contribution on energy, but thank you for being here to learn from some great Alaskans about our opportunities.

Mayor, it is your town. I will allow you the final word, if you will.

Mr. KOPLIN. Well, thank you, Senators, for your leadership and what you're doing for energy and energy policies in this country and holding these kinds of hearings and reaching out and helping us bridge that gap as communities, as a state, as a region, the Pacific Northwest and as a country and ultimately as the world. We do have a lot to share.

Gwen and I were talking last night about deploying smart grid technologies and we both worked lately with some Australian communities that are way ahead of us and we're thinking we need to go there and work with them.

That would be really tragic. We have those technical resources here. We would much rather be working with our own technical labs, but there's so many connections here.

Avista, now the electric utility for Juneau, was my path to call my friend, Tim McCloud, that manages that utility and say, hey, they're looking at this great battery opportunity down in Avista or down in Pullman, Washington, that I'd like to look at and it's right there at Schweitzer Engineering labs that make the relays that help keep the lights on all the time.

So there are all these little connections, and I think that's part of what we do, too, is we communicate well.

So let's keep the conversation going.

Thank you.

The CHAIRMAN. Senator Cantwell, the last thing I am going to leave you with is a pull-out from the Alaska dispatch from last week. The article is, "What Alaska can teach the world about renewable energy."

We are making it happen here every day.

With that, ladies and gentlemen, I thank you for your contribution and for those who have stayed throughout the morning, we greatly appreciate it.

The Committee stands adjourned.

[Whereupon, at 12:06 p.m. the hearing was adjourned.]

APPENDIX MATERIAL SUBMITTED

Geoffrey Larson
Co-founder and President
Alaskan Brewing Company

Innovation in Action – Micro grids and Hybrid Energy Systems
Senate Committee on Energy and Natural Resources
Saturday, June 10, 2017 - subsequent written testimony

After my testimony and questions, I wanted to follow up on two questions, one from Chairman Murkowski and one from Ranking Member Cantwell.

During the question and answer period Chairman Murkowski asked what could be done to further the innovations in Micro-grids and Hybrid Energy Systems. I tried to make mention of the financial cost involved for those pioneering burgeoning new technology. I do want to point out that Alaskan Brewery did receive a grant from the Department of Agriculture Rural Development with their Rural Energy for America Program, to partially pay for some of our capital equipment. And this support was strategically beneficial, as we ended up having to rebuild the combustion chamber after the initial trials. This subsequent repair cost exceeded the grant we had received. While there has been government support, I believe extending the development time that existing tax credits cover could supply an improved vector to defray the cost of developing new and novel technologies that significantly change energy development or use. Many times, truly innovative processes have an extremely long development time. As an example, our work with our Spent Grain Boiler was awarded a process patent for this unique and novel combustion technology that involved three distinctive steps. The first step in the long development time of this process started in 1995 with the installation of the Grain Drier (step 1), that was followed by the installation of the Mash Filter Press installed in 2007 (step 2) and then finally we installed the Spent Grain Boiler in 2011 (step 3), and we are just now realizing the benefits nearly 22 years later after the first step that lead to our receiving a patent for this new novel integrated process that is comprised of those steps 1,2 and 3. To our knowledge we are the first brewer to use Spent Grain as the sole fuel in a steam boiler, and the issuance of the process patent does support this assertion. While some tax credits are available, the look back time for their accumulation is less than ten years. Innovation takes time, especially for small companies like Alaskan Brewing. We are just now implementing and developing the full energy savings potential this innovation created. One suggestion I would make is to have longer look back periods for tax credits that are tied to Micro-grids and or Hybrid Energy systems. In our case it has been over twenty years from our first steps towards realizing a benefit from our Hybrid Energy System.

The second question I would like to better respond to came from Ranking Member Cantwell who asked for clarification of our 60% target for fossil fuel use reduction in light of my comments about our electrical usage. The two main energy needs at Alaskan Brewing are steam and electricity. Steam is primarily used for the brewing but it is also used to a lesser degree for cleaning and sanitizing operations. We currently have two steam boilers; one is a conventional oil fired steam boiler, and the other is our spent grain fired steam boiler. Our spent grain boiler is now significantly replacing the need for steam to be generated by our oil fired boiler. The Second energy need is electricity, which is primarily used for refrigeration in addition to other process equipment and lighting. Of these two energy sources, electricity accounts for 1/3 of our total energy needs. By the end of 2017 we will be

integrating an electrical co-generation plant with our Spent Grain boiler to replace a portion of our electrical needs. Alaskan Brewing will be using all of this generated electrical energy solely within our operations and will not be supplying any of this electrical energy to the local grid supplied by our local electrical utility provider.

The steam coming from our spent grain boiler is being stepped down in pressure using the co-gen plant, rather than using pressure reducing valves. By using a co-gen plant we are capturing the energy of this step down in pressure by generating electricity. We are monitoring our electrical use and are using processes like this to reduce our peak loads, so while the amount of electrical generation is low its impact on our overall industrial billing from our utility is more significant. As an industrial user of the electricity supplied by our electrical utility, our billing is based upon our monthly use of total kw-hrs, with surcharges factored in our billing for our power factor and for our peak loads during the month. The power factor is based upon the inefficient voltage and current phase shift caused by unbalanced inductive and capacitance use of the utility's electricity. We condition our power use to eliminate this inefficiency and hence eliminate our utility's power factory surcharges. And we expect to be using our electrical generation from this spent grain boiler co-gen plant to help reduce our peak loads.

In essence our interface with our utility is dynamic yet independent of our electric utility. It would be helpful to foster more integration of our operations with our utility. The simplicity of the methods used for our billing as a single user does not take into account the efficiency that could be created with the integrated whole of all users of the utility. Industrial users could make a better difference if our electrical utility provider were to be allowed more flexibility in integrating use patterns and subsequent charges in the context of all of the customers.

Thank you for this opportunity to submit additional information to the Committee.

Geoff Larson